POWER

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Salesmanship

A FRIEND and schoolmate sends me the following as his definition of a salesman:

> He who possesses the ability to convincingly express sincere belief based on thorough knowledge.

The definition is based on a real appreciation of the social-economical function of the salesman.

He rejects the expression "salesmanship is the convincing expression of sincere belief" as incomplete when applied to the salesman, because the salesman may be sincerely convinced that what he is selling is the best thing for the customer to buy when it is not; and so he adds, "based on thorough knowledge."

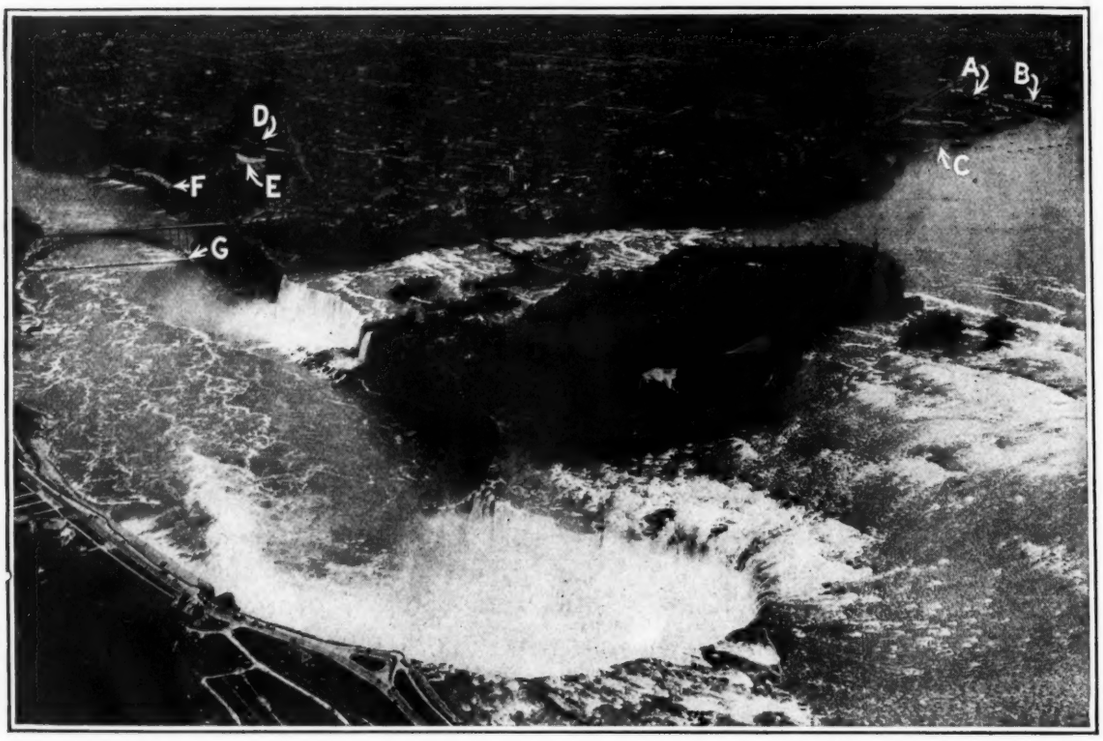
A salesman with a real knowledge of the needs and conditions and purposes of his prospect, of the adaptability and limitations of his own wares and those of his competitors, cannot "convincingly express sincere belief" that his are the best for the customer to buy if there is something better adapted to his circumstances, nor can he, through the expression of such sincere belief, sell him from his own list something less well adapted to his needs than another because there is more profit in it. Neither can he force a sale through the guaranteeing of performances that with a thorough knowledge of the possibilities of his apparatus he has not a sincere conviction can be ordinarily attained under the conditions in which it will be used.

Salesmanship has been defined as the ability to create in the prospect a desire to possess the thing that one is selling. Would a conscientious salesman dissuade a man from mortgaging his house to buy an automobile?

I know a salesman who lost his job because he told a possible customer that he did not need his apparatus, and showed him a simple and inexpensive way of accomplishing the purpose for which he was about to buy it.

The salesman who lived and worked by my friend's definition would be more than a hawker of wares. He would perform a real advisory service to his customer and to his customer's patrons. It was such an idea that I tried to get over in a recent foreword on "Good Will."

F. R. Low



Airplane view of Niagara Falls and power plants on American side of Falls[1]

Hydro-Electric Plant Has 452,500 Hp. Installed Nominal Capacity

THE Niagara Falls Power Company has recently completed a 210,000-hp. extension to its Hydraulic Plant No. 3, which gives this station the largest available operating capacity of any plant in the world. For short periods the plant could carry over one-half million horsepower load. The new extension consists of a concrete-lined horseshoe-shaped tunnel 4,300 ft. long by 32 ft. inside diameter, three concrete-lined penstocks 21 ft. inside diameter, three butterfly valves 23 ft. 6 in. inside diameter, three Johnson valves 24 ft. 4½ in. outside diameter, and three 70,000-hp. vertical-shaft single-runner turbine units. All these are the largest that have ever been constructed. This article describes the engineering features of the project down to the turbines; subsequent articles will treat of the turbines and electrical equipment.

WHEN in 1852 the Porter family, whose estates consisted of a large farm at Niagara Falls, donated a strip of land 100 ft. wide for the construction of a canal, beginning at a point about one-half mile above the Falls and ending about 4,000 ft. below, it is doubtful if any of them dreamed that along this route water would be conducted for the largest power house in the world. Whatever genius and foresight dominated this act has been rewarded by the recent completion by The Niagara Falls Power Co. of extension No. 3-C, to its Hydraulic Plant No. 3.

This extension consists of three 70,000-hp. units, the largest power generating machines that have ever been put into operation, which gives the plant a nominal rated capacity of 452,500-hp., although for a short period it could supply one-half million horsepower if the water to carry this load were available. The beginning of actual work on this great project was started by Walter Bryant who, in the same year that the Porter family made the land grant, began to dig what today is known as the hydraulic canal. This undertaking proved a failure after Bryant and his associates had lost about $300,000. The task was later taken up by Horace H. Day and others, who sank $700,000 more in the project only to meet defeat. The third attempt, which proved successful, was started in 1877, when Jacob F. Schoellkopf and his associates purchased the canal property at public auction and began work. Such is the history in brief of the beginning of this world-renowned power development, and in this description of its completion it is fitting that those early pioneers who sacrificed so much should be given just mention for their vision and daring. The canal as first dug was 35 ft. wide and 8 ft. deep, but was later enlarged at various times until it was 100 ft. wide and about 16 ft. deep, the last enlargement being made in 1918 and 1919

[1] In the headpiece *A* and *B* are the two powerhouses of the old Niagara plant, placed in reserve when No. 3C extension went into operation; *C*, canal and tunnel intakes; *D*, gatehouse at lower end of tunnel forebay; *E*, canal basin; *F*, station 3C, which is an extension of the hydraulic plant 3A and 3B; and *G* the discharge of the tailrace tunnel from old Niagara plant.

to give the necessary capacity for supplying water to the three 37,500-hp. units installed in extension No. 3-B to Hydraulic Plant No. 3. These three, combined with the thirteen 10,000-hp. units installed in this plant, brought its capacity up to 242,500 horsepower.

In addition to Hydraulic Plant No. 3 the company operates an additional plant on the American side of the Falls on the Niagara River a short distance above the hydraulic canal intake. The first units in this plant began operation in 1895 and was the first attempt to produce power at the Falls on a large scale. This plant operated under a head of 140 ft. and produced only about one-half as much power per second-foot of water as can now be produced in the modern-type units in Hydraulic Plant No. 3.

Since Hydraulic Plant No. 3 had only about sufficient capacity to utilize half of 19,500 sec.-ft. diversion for power purposes on the American side of the Falls, the other half had to be used in the less efficient units of the older plant. These were the existing conditions when, on March 2, 1921, the Federal Water-Power Commission issued its first license under the Federal Water Power Act. This license gave the company the right for fifty years to use all the water permitted to be diverted from above the Falls on the American side of the Niagara River except 500 cu.ft.-sec., in accordance with the existing treaty. This license also gave formal approval to plans already developed by the company for using the two old plants for stand-by service and using this water in a second extension to Hydraulic Plant No. 3.

To deliver this water at the proposed new plant required enlarging the present canal or constructing a new waterway. To enlarge the canal would have meant obtaining additional property for lateral expansion or extensive dredging for deepening in rock. Either would have been expensive on account of property cost, and the dredging would have to be done in currents as high as 6 ft. per sec. Careful analysis showed a pressure tunnel to be the most economical, and it could be constructed largely on property owned by the company. Furthermore, it was known that the bottom of the present canal was very rough, causing an unnecessary loss of head. Previous excavation had been made in solid rock under water in swift currents, which practically excluded a smooth job. This made unwatering the canal desirable so that the bottom and sides could be cleaned up. Construction of a tunnel with connections to the canal forebay would allow making the desired improvements in the canal. For these reasons a pressure tunnel was adopted as the waterway for the new extension.

The tunnel was designed for a capacity of 10,500 cu.ft.-sec. with a velocity of 12 ft. per sec. It is of horseshoe shape, 32 ft. in diameter, is cut in solid rock and is concrete lined throughout its entire length of 4,300 ft. As indicated in Fig. 2, the tunnel intake is adjacent to that of the canal. At this point the company owned a tract of land that could be used for this purpose. This made it possible to utilize the same intake works in the river for both the canal and tunnel, saving thereby a duplication of the extensive arrangements of booms and piers required to deflect ice. Although these provisions had to be considerably modified, the engineers could deal with the problem with a high degree of certainty on account of their previous experience with the ice problems in this part of the river.

The intake to the tunnel consists of a spreading mouth cut in the rock bottom of the river and controlled by concrete side walls and gate piers. No gates are provided for the entrance, but in their stead a steel

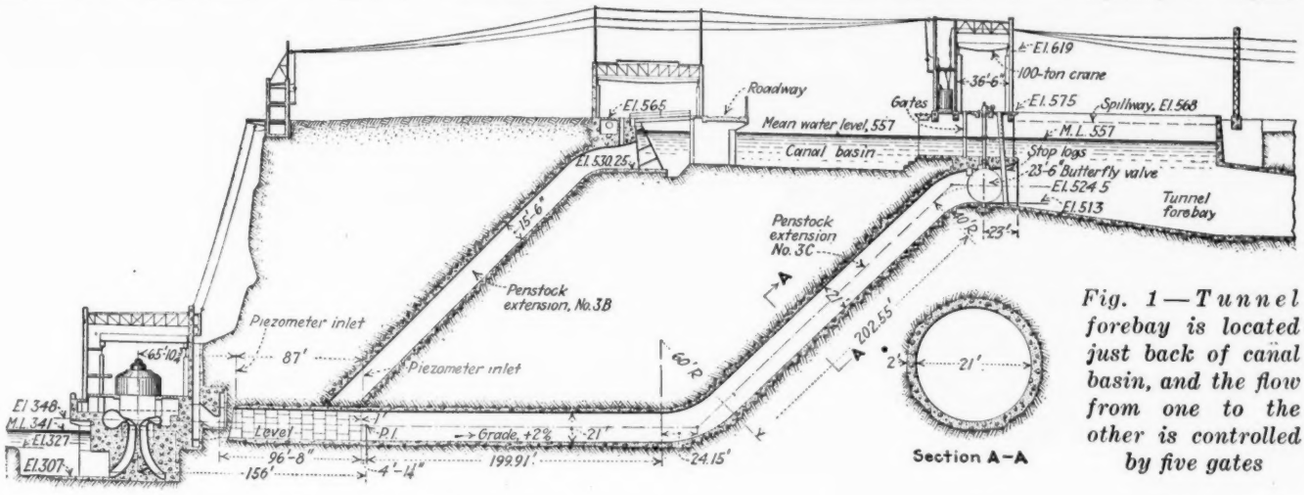


Fig. 1—Tunnel forebay is located just back of canal basin, and the flow from one to the other is controlled by five gates

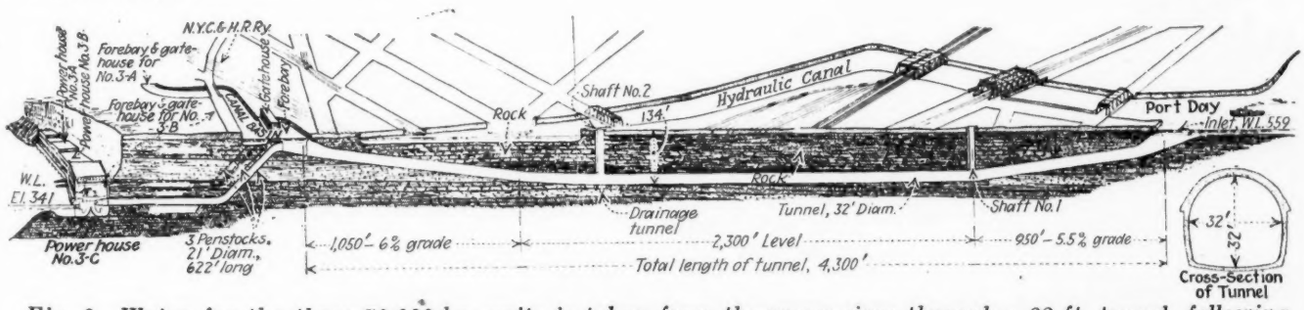
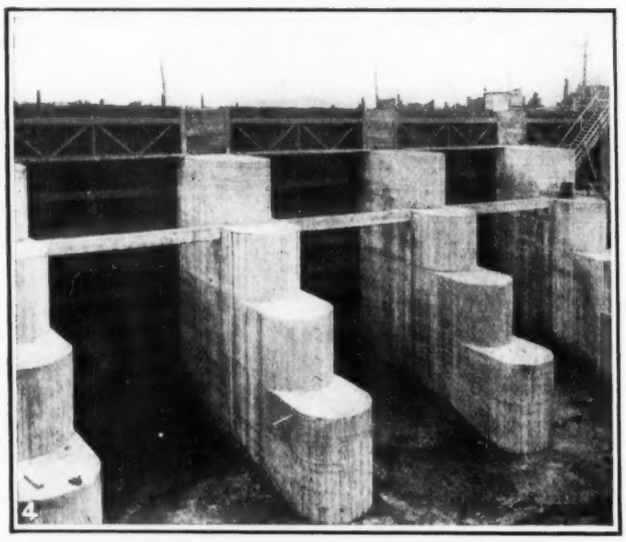
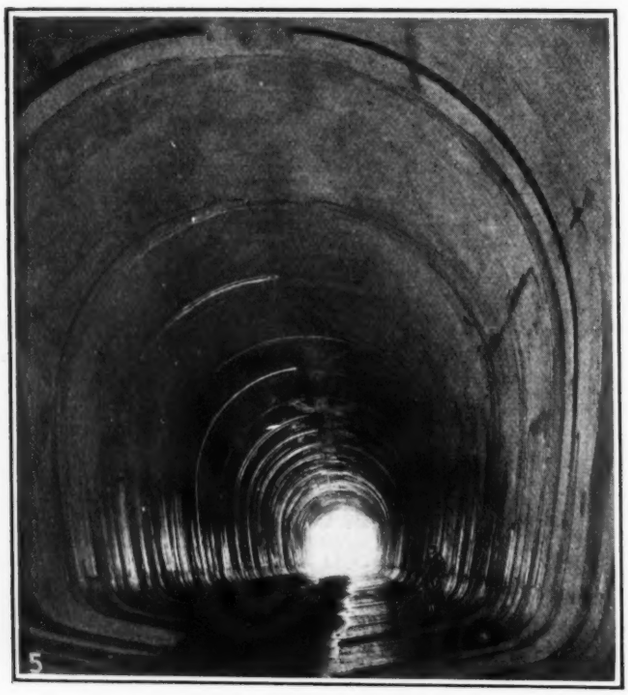


Fig. 2—Water for the three 70,000-hp. units is taken from the upper river through a 32-ft. tunnel, following practically the same course as the canal for plants 3-A and 3-B





framework of I-beams can be placed between the piers and Lackawanna interlocking steel piles placed on the upstream side of the I-beams, as indicated in Fig. 4. This arrangement not only reduced the cost of the gate construction, but did not require any permanent gate-handling equipment, since if it ever should become necessary to unwater the tunnel, the steel framework and piles can be placed from a boat.

Fig. 2 shows the course of the tunnel and its grades. At the lowest elevation it is 134 ft. below the earth surface. In constructing the tunnel, most of it was driven from the two intermediate shafts. From the bottom of shaft No. 2, which was the lowest point, a 6-ft. adit was driven into the tailrace tunnel from the old Niagara plant, and this was used to drain the entire tunnel during the latter part of the work. When the tunnel was lined a connection was made with the drainage tunnel by a valve that can be reached through shaft No. 2. This provides a means of easily unwatering the main tunnel should such an expedient become necessary.

Providing a Forebay for Tunnel

As can be seen from Figs. 1, 2 and 9, the tunnel terminates in a forebay just back of the canal basin. Selection of this location was necessary, as it was the only piece of land on the company's property available for the headworks. This site is restricted by the canal basin on two sides and the New York Central Railway tracks on the other. Fig. 9 shows that there was not room for the headworks in an extension to the gate-house of station No. 3-B and the property line. This location of the tunnel forebay necessitated driving the penstocks under the canal basin.

In fact, the property restrictions and the amount of water available determined the size of the units. It was found that a 210,000-hp. extension could be made to plant No. 3 by putting this in three units of 70,000 hp. each, and the three penstocks brought down under the company's property. For a greater number of units this could not have been done, therefore the number was restricted to three, not because of any desire to construct the largest machines in the world, but owing to engineering considerations. By making the scroll cases on the new units the reverse of the 37,500-hp. machine in extension 3-B, it was possible to obtain liberal spacing of the machines (see Fig. 9).

On account of the restricted space available to drive the penstocks under the canal basin, it was necessary to locate the bottom of their entrance 43 ft. below normal water level in the forebay. Another consideration in this was providing a connection between the tunnel and canal forebay controlled by gates so that one waterway might be used independently of the other. Provisions had also to be made for taking care of surge in the tunnel's forebay in case of dropping of load on the 70,000-hp. units.

A number of different entrances to the penstocks were designed before a satisfactory conclusion was reached. This problem was made more difficult on account of

Fig. 3—Condition of canal before it was cleaned out. Fig. 4—Gate piers at entrance to tunnel. A steel framework can be placed against these piers and the water shut off with interlocking sheet-steel piles. Fig. 5—Interior of tunnel after concrete lining had been placed, which is 32 ft. inside diameter

providing gates in the penstock mouths. A double-mouth intake was carefully considered, but a single intake was finally decided upon after it was found possible to have designed and manufactured butterfly valves 23 ft. 6 in. in diameter, the largest valves of this type that had been attempted. This construction was not only the most satisfactory from hydraulic considerations, but also in point of construction costs, the latter being due largely to the reduction in the amount of excavation and concrete work.

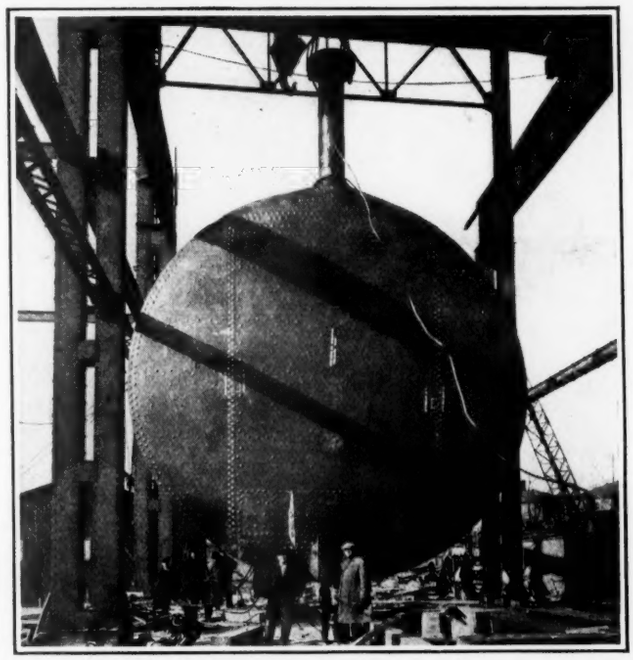
The design of the wickets for the butterfly valves is rather novel. It was not possible to obtain a steel casting of such large dimensions, so the wickets were built up of steel girders and 1½-in. steel plates. At the top and bottom the plates are riveted to cast-steel segments, through which the shaft passes. The lower section of this shaft is 35 ft. long, is made of forged steel with an average diameter of 22 in. and extends through the valve. One wicket complete and assembled on the lower section of the shaft is shown in Fig. 7, ready to be lowered into place in its cast-iron housing in the penstock. This section of the shaft is double keyed to the wicket and is provided with a forged steel flange at the upper end. Directly above the section are two intermediate sections, each 13 ft. 2 in. long, made of steel, cast hollow. The top section is 7 ft. 3 in. long and is cast solid with the operating lever. This makes the total length of the shaft 68 ft. 7 in.

One of the interesting features of these valves was the machining of the wicket's periphery so that they would make a tight fit with their seats when closed. On account of the extreme diameter of the wickets and the head, they are subjected to some deflection on the side that has to close against the pressure. This deflection was taken into consideration in machining the wickets so that they would close tightly without any snap rings or other staunching devices.

Housings for the Butterfly Valves

The cast-iron housings of the butterfly valves are made in sections, as their extreme diameter is 26 ft. 6 in. The valves are designed to withstand a water pressure equivalent to 50-ft. head. Fifty feet is the head measured from the surface of the water at maximum surge to the center line of the valve. The pressure of the water against this large diameter of the valve requires the valve to resist a thrust of 1,355,000 lb. This force is taken on the upper and lower trunions, which are supported in bronze bearings. These bearings are 19 in. in diameter and 42 in. long, giving a bearing pressure of 850 lb. per sq.in. The vertical shaft from the wicket passes up to the operating floor of the gatehouse, a lever is fitted to the end of the shaft and connections are made to an operating cylinder with a piston 30 in. in diameter and 70½-in. stroke. Oil under 200-lb. pressure serves for opening and closing the valves. An automatically controlled oil-pressure equipment is provided and pressure maintained.

On account of the short length of the horizontal in-



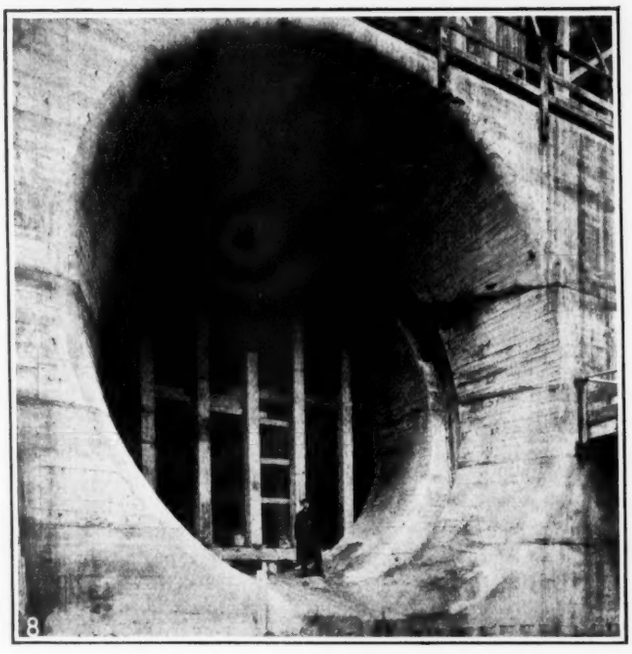


Fig. 6—View of canal after it had been cleaned out, taken from about the same point as Fig. 3. Fig. 7—Wicket for one of the three 23-ft. 6-in. valves installed in the mouth of the penstock. Fig. 8—Mouth of one of the three concrete-lined penstocks, which are 21-ft. inside diameter

take the butterfly valves had to be located in the bell mouth and not in the penstock proper. This required a valve 2½ ft. greater in diameter than the normal diameter of the penstocks. Bending of the penstocks downward so near the mouth was necessary in order to keep the excavation away from the bottom of the canal basin a safe distance without making the tunnel forebay excessively deep. As the final design worked out, each penstock is controlled by a single butterfly valve in its intake, with five structural-steel and concrete gates located above the penstocks' intakes to control the flow between the tunnel forebay and canal basin (see section *AA*, Fig. 9). The two gates between the penstocks are provided with motor-operated hoists so that they may be raised and lowered at will. The other three gates, which may be dogged in any position, are low temperature so as to maintain their temperature above the freezing point.

In addition to housing the gates and gate-hoisting equipment, the gatehouse contains the high-voltage transformers which step the 12,000-volt current from the generators up to 66,000 volts for transmission to Echota substation. These transformers are set in an open gallery at the rear of the gatehouse, which protects them from the weather but at the same time gives free access. The upper part of the building over this gallery is inclosed and houses the current and potential transformers for the protective equipment of the main transformers and also contains the lightning arresters.

The work on the tunnel and headworks was rushed to completion about eight months ahead of the time for starting the first main generating unit. This allowed

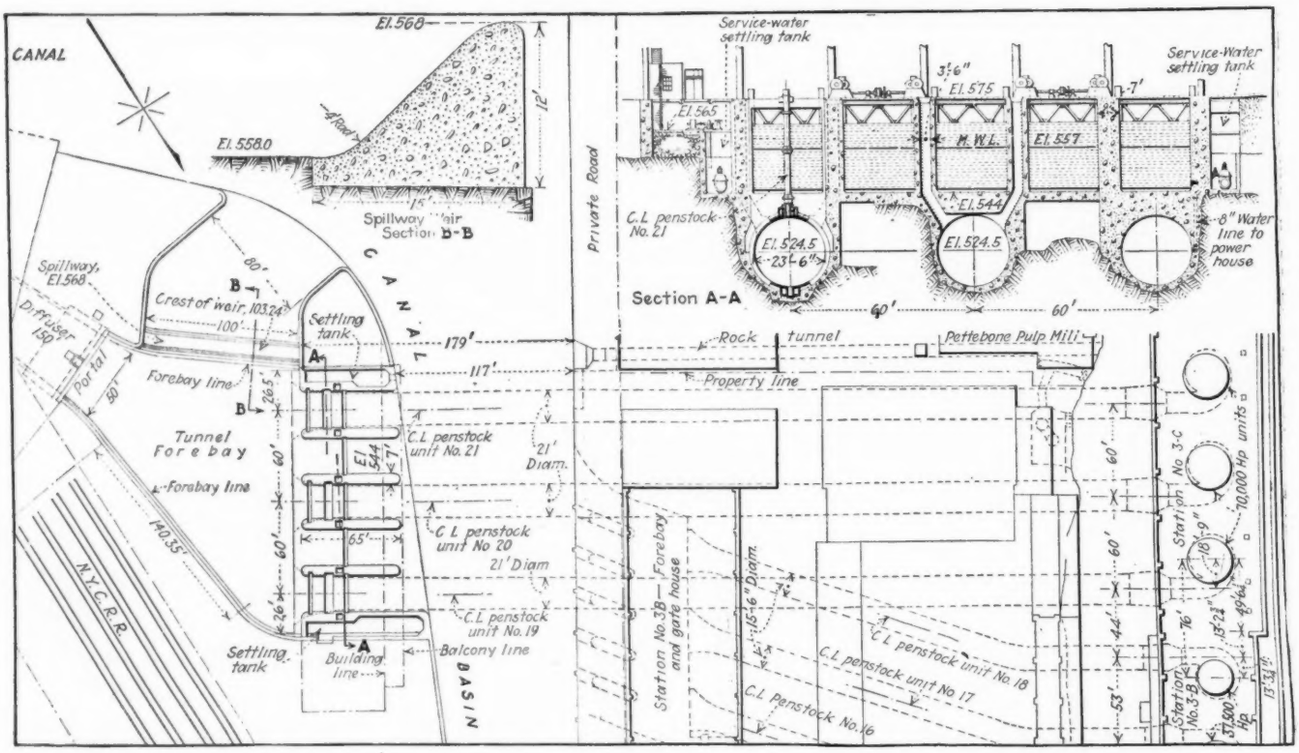


Fig. 9—Penstocks for extension 3-C pass under the forebays for extensions 3-A and 3-B

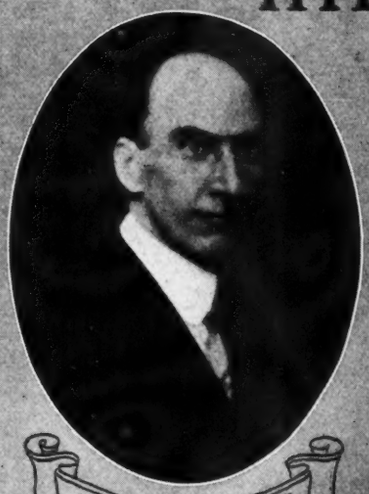
raised and lowered by a 100-ton crane and will normally remain closed. This arrangement saves the cost of three hoisting equipments, as the crane had to be installed for placing and removing the stoplogs in the penstocks' intakes and handling of the transformers.

At each end of the gatehouse a settling tank has been provided for the water used in the turbine guide bearings and the cooling coils of the transformers. These tanks are arranged with valves so that water may enter from either end and be taken from the other end. In passing from one end of the tank to the other, all sand and other matter has time to settle from the water. An 8-in. pipe leads from each of these settling tanks to the power house. The pipes run down the inside of the penstocks and are embedded in the concrete lining.

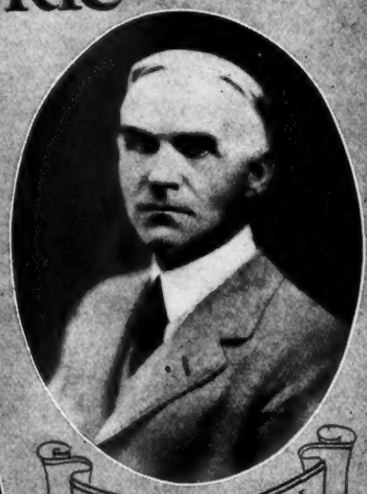
Cooling water for the main transformers is pumped from these settling tanks. Normally, the discharge from the transformers' cooling coils will go into the forebay. Provisions have been made for returning the discharge to the settling tanks during the periods of closing each end of the canal with a cofferdam and smoothing up the bottom and sides. Figs. 3 and 6 give an idea of the conditions of the canal's surfaces before and after cleaning out. The unwatering of the canal was done by draining through a connection with the tunnel drain and pumping out the low spots.

The penstocks, which are 21 ft. inside diameter, are cut in solid rock and have a concrete lining of 2 ft. minimum thickness. They have a total length of 600 ft., the lower 96 ft. being lined with steel plates. This lining, which consists of twelve 8-ft. sections made of 1⅜-in. plate, forms an impervious reinforcement and connection between the Johnson valve and concrete lining in the penstock. At the valve the plates are increased to 1⅝ in. thickness. Calculations have been based on an 82 per cent joint efficiency throughout the riveted-plate construction. The design was worked out so that the steel would be capable of standing the total head due to a rise in pressure on a governing time of complete travel of the turbine gates in two seconds and

Some of the Men Responsible for the INSTALLATION *of the* WORLD'S LARGEST HYDRO-ELECTRIC UNITS



J. ALLEN JOHNSON
ELECTRICAL ENGINEER



NORMAN L. GIBSON
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GEO. R. SHEPARD
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DESIGNING ENGINEER

OLIVER D. DALES
CONSTRUCTION ENGINEER

not increase the fiber stress in the steel above 15,000 lb. per sq.in., although the actual time setting of the governors is five seconds. Dropping full load on a two-second governing time gives a rise in pressure of about 150 ft., making a total head of about 350. Around both ends of the inner section of the lining is riveted an 8x8x1⅛-in. angle to anchor the plate lining to the concrete and to prevent leakage between the steel plates and concrete.

Each Johnson valve, one of which is shown partly assembled in the shop, Fig. 10, has an inlet 21 ft. in diameter and an outlet of 14 ft. A short piece of 14-ft. pipe joins it with the scroll case. These valves, which are the largest in the world, have a 30-ft. over-all length and a maximum diameter of 24 ft. 4½ in. One complete valve weighs 307 tons, the plunger or moving element alone weighing 54 tons. Ten railroad cars were required to ship each of the three valves. The main

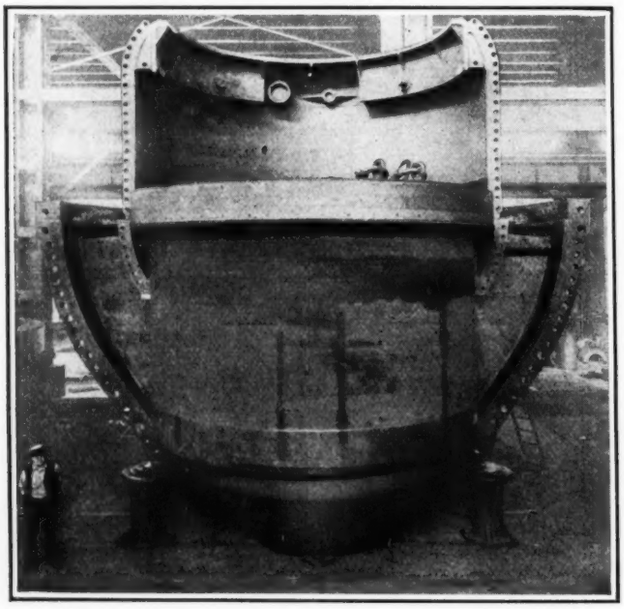


Fig. 10—Johnson valve partly assembled. Valve is shown in a vertical position, where the normal position is horizontal

portion of the valve body is made in quarters to meet railroad shipping clearances. The body, which is subject to the stress, is of cast steel 2⅝-in. thick. The erection of the valves was greatly facilitated by installing temporarily a 50-ton traveling crane in the bays where the valves were being installed.

The plunger travels a linear distance of 6 ft. 4½ in. when moved from its wide-open to shut position. The operating forces that move the plunger are produced entirely by control of the hydraulic pressures in the operating chambers, this pressure being taken directly from the penstock. When the valve plunger is closed and the wheel casing empty, there is an available opening force of 565,000 lb. to unseat the plunger and prime the casing. After the casing is primed, the available opening force increases to 2,820,000 lb. Likewise in closing, the available force is 565,000 lb. throughout the stroke or until the pressure in the casing beyond the valve is reduced below normal penstock pressure. When the plunger is seated or when the valve is being operated in an emergency, there is available a maximum closing force of 2,820,000 lb. The force moving the plunger is equal to the force opposing the movement plus the friction of the plunger in its guide. As long as the plunger moves freely, the two opposing hydraulic forces are nearly equal because the friction is low. If, however, the valve is clogged or obstructed, the friction element increases and more difference of hydraulic pressures is required to overcome it and keep the plunger in motion. This additional force is automatically developed and cannot exceed what is actually required.

The controls for operating the valves are on the power-house floor immediately above the main valve bodies. An indicator and gages are mounted on a board above the operating handle for each valve, so that the operator controls at will the movement of the plunger.

Provisions are made for closing the valves from a remote control station on the switchboard. Automatic closure in emergency is also provided for should the velocity through the valves substantially exceed full-load velocity and the remote-control station or its connections be wrecked by an accident in the power house.

The valves are set to open or close in approximately four minutes regardless of the flow through them. A recent test demonstrated the positive nature of the valves' closure in flowing water. The unit was fully loaded, there being a flow through the valve of approximately 3,700 sec.-ft. which corresponds to a velocity of 24 ft. per sec. at the valve outlet. Under these conditions the control handle was operated and the valve plunger moved toward its closed position. With the valve half closed the velocity of water had increased to 48 ft. per sec. with very little drop in the power output of the unit. As the plunger progressed, the power output decreased until when three-quarters closed the wheel-casing pressure was reduced nearly to zero, indicating substantially spouting velocity through the valve outlet. The plunger at this point was still 19 in. from the seat. Further progress of the plunger cut off the flow and stopped the machine and the valve plunger seated without shock or sound. The rate of closure was uniform throughout the stroke except for a slight retarding of the rate just before the plunger seated. The total time of closure during this test was four minutes, but the flow of water was cut off by the last 20 per cent of the stroke, hence the entire flow of 3,700 sec.-ft. was cut off in less than one minute.

The next article will describe the power house and turbines.

This work was planned and carried out under the supervision of the late John L. Harper, vice-president and chief engineer of The Niagara Falls Power Co., and his staff; George R. Shepard, assistant chief engineer; Norman L. Gibson, hydraulic engineer; Oliver D. Dales, construction engineer; J. Allen Johnson, electrical engineer; Louis S. Bernstein, designing engineer; and A. Kay, field engineer. Most of the foregoing names are also identified with the firm of Harper & Taylor, Inc., consulting engineers. Read-Coddington Engineering Corp. had charge of the construction work. *Power* wishes to acknowledge their assistance and co-operation in preparing this article. Information on the butterfly valves was obtained from William M. White, chief engineer and manager, Hydraulic Department, Allis-Chalmers Manufacturing Co., designers and manufacturers of these valves; and on the Johnson valves from O. V. Kruse, consulting engineer, I. P. Morris Department, Wm. Cramp & Sons Ship & Engine Building Co., designers and manufacturers of this equipment.

Operating Centrifugal Pumps in Combination

By RUSSELL K. ANNIS

HOW many engineers can make a rational selection and application of a new centrifugal pump to supplement an old pump in meeting enlarged demands of capacity, pressure or both? Mr. Annis here shows how easy it is to solve such problems along scientific lines. The widespread use of centrifugal pumps makes this information an essential part of the equipment of the all-around engineer.

THE question is often asked, "How can I increase the capacity of my centrifugal pumping outfit? I would like to add another pump, but do not know whether I need more pressure or just more pump capacity." A description of the present pump is generally given, and it is desired either to purchase a new pump to use with it, or to use to the best advantage another pump that is already at hand.

There are two general methods of connecting a new pump into a line in order to increase the capacity, and

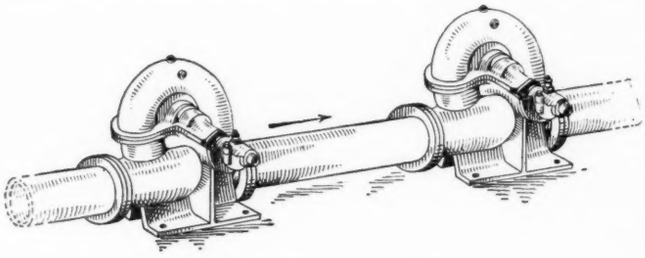


Fig. 1—Two pumps arranged in series

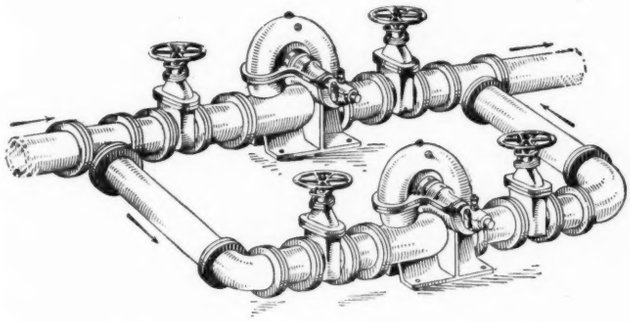


Fig. 2—Two pumps arranged in parallel

one of these, known as the "series" arrangement, is shown in Fig. 1. When pumps are connected in series, the discharge of one is connected into the suction of the next, and the same water passes through each pump, the resulting pressure being the sum of the pressures of the two pumps.

The other arrangement, known as the "parallel" connection, is shown in Fig. 2. Here the heads against which the two pumps act are necessarily the same, and the total capacity is the sum of the individual capacities.

It can be seen that these two forms of connection are the same as series and parallel connections for electrical machines. The results obtained from connecting

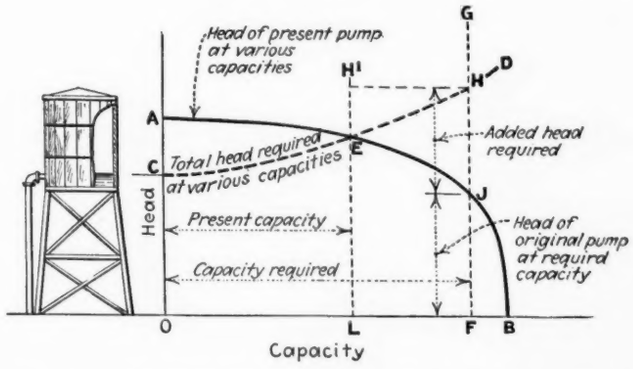


Fig. 3—This solution shows that a pump is needed in series, capacity OF, head JH

pumps in combination are also analogous to electrical machines, in that the series connection is used to build up pressure for pumps and electrical pressure, or voltage, for generators; while the parallel connection increases the rate of flow for pumps, which is the equivalent of amperes of current in a generator.

Sometimes, however, it is necessary to increase the pressure in order to get increased capacity, while, on the other hand, the capacity can sometimes be increased directly by using the parallel connection. In other words, there is no general answer to the question of increasing the capacity of an outfit; sometimes a series connection is better and sometimes a parallel, and the decision can be made only by correctly analyzing the conditions.

Each Case Must Be Studied Separately

A case has been known where a small pump was added to the discharge line of a large pump, making a series connection with it, and this caused a decrease in capacity, owing to the smaller passageways in the small pump. The small pump was then taken out and connected across the large pump, making a parallel connection, again resulting in decreased capacity, this time due to the fact that the small pump could not maintain the line pressure equal to the large pump, and the water was flowing through it in a reverse direction. In a case of this kind it is impossible to get satisfactory results by either method, and if the conditions had been analyzed beforehand, much trouble could have been avoided.

One solution to this problem is shown in Fig. 3. When the conditions are such that this method can be used, the new pump should be arranged in series with

the present pump. The characteristic curve of the pump —that is, the relation between head and capacity—is represented by *AB*. The curve showing discharge pressures at various capacities is represented by *CD*. The curve *CD* crosses *AB* at *E*, which must be the head and capacity at which the present pump is operating. In other words, the present capacity is *OL*, and the pressure *LE*.

The capacity to which it is desired to increase the outfit is represented by *OF*. The line *FG* is now drawn perpendicular to the base line. This intersects *AB* at *J*, and it also intersects *CD* at *H*. The point *H* represents the new head and capacity of the outfit, and the distance *JH* represents the head that the new pump will be required to develop, while *FJ* represents the head which the present pump will develop at the new capacity.

Sometimes Parallel Connection Is Better

It sometimes happens that *EH'* is specified as the head required for the new pump, but this is not correct, as it takes into account only the increase in friction, but not the decrease in the head developed by the present pump.

The second case is shown in Fig. 4. Here the increased capacity *OF* is greater than the maximum

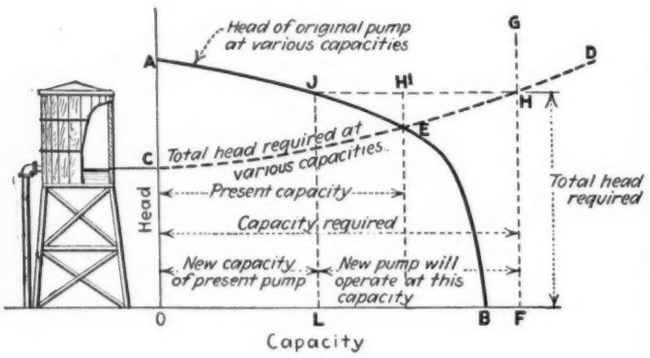


Fig. 4—Required: A pump connected in parallel, capacity LF, head FH

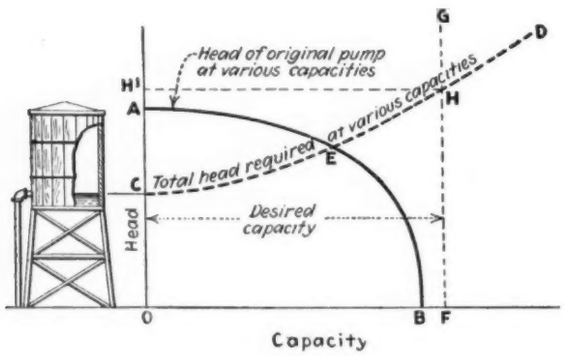


Fig. 5—Present pump cannot be used. New pump required, capacity OF, head OH'

capacity *OB* of the present pump and a parallel connection is required. Proceed as in Fig. 3, plotting the characteristic curve *AB*, the total head curve *CD* and the new capacity line *FG*. The point *H* represents the new head and capacity, and *HJ* is drawn parallel to the base line *OF*. The point *J* then represents the new conditions of head and capacity under which the present pump will work, and the distance *JH* (equal to *LF*) is the required capacity of the new pump, which acts against the head *FH*.

The two pumps should be connected in parallel, and they will both work against the same head *FH*, the present pump developing a capacity of *OL* and the new pump a capacity of *LF*. The actual added capacity will be *HH'*, but the capacity of the new pump must be greater than this by an amount represented by *H'J*,

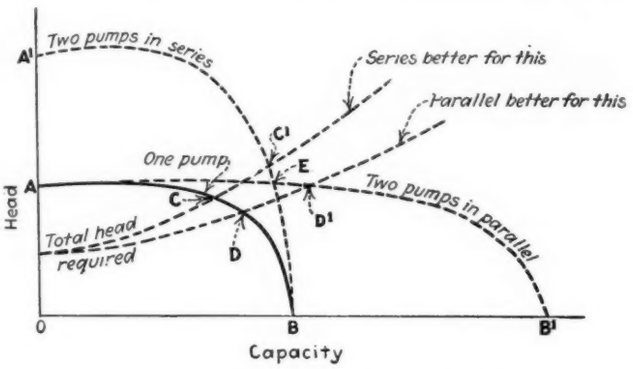


Fig. 6—A problem of variable capacity

due to the loss in capacity of the present pump when working against the increased head.

Another condition is shown in Fig. 5. In this case neither of the perpendiculars from the point *H* intersects the characteristic curve *AB*, and there is no solution. In other words, there is no possible way to use the pumps in combination, and a new pump will have to be used that is capable of developing both the head and the capacity represented by the point *H*.

Fig. 6 shows the method of determining the best arrangement for connecting two pumps where the rate at which water is required varies and where it is desired to increase the maximum available capacity. The curve *AB* is the characteristic curve of the pump, and it is assumed, for simplicity, that the pump to be added is a duplicate. If not, the solution would be the same.

Connecting Two Pumps for Maximum Capacity

The curve *A'B* is plotted in by adding together the heads produced by the two pumps at various capacities. The result is the combined characteristic for both pumps in series. Similarly, the curve *AB'* is the characteristic curve for the pumps when arranged in parallel, and it is plotted by adding together the capacities of the two pumps at various heads.

The point *E*, where the two curves cross, represents the one condition that could be obtained by arranging the pumps either in series or in parallel. For greater capacities than that represented by E, the pumps should be arranged in parallel, but if a greater head is required, a series arrangement should be used. A good method for determining whether the head is great enough, is to plot out on cross-section paper a diagram similar to Fig. 6 and note where the total-head curve crosses the combined curves. If it crosses above the point E, as at *C'*, use a series arrangement. On the other hand, if it crosses at *D'*, to the right of *E*, use the parallel arrangement.

In cases where the friction is negligible, the position of the required head with relation to the point *E* determines the best arrangement. If the required head is greater than *E*, use the series arrangement; if less than *E*, use the parallel.

Fig. 6 merely shows how to determine the *maximum capacity that may be expected* from two pumps whose characteristic curves are known, while the other method showed *what size of pump was required* to obtain a given condition of head and capacity.

Sometimes, as in the case of mine work, it is desired to add a new pump at a point somewhat distant from the present pump, usually as close to the entrance of the mine as possible to reduce the electrical resistance, and also in order that repairs may be made more conveniently. This, of course, requires a series connection. The new pump should not be placed so far away from the present one that the higher pump will be "starved" from operating at too high a suction lift at the increased capacity.

This condition can be avoided by plotting out the curves as shown in Fig. 3, and then the new pump can be placed at such a point above the present one that the head as indicated by *FJ* will not be exceeded.

Arranging Two Pumps in Series

In Fig. 7, which shows the arrangement of two pumps located at some distance from each other, *A* is a horizontal line drawn from the point of discharge, and *F* is a line plotted above this to allow for the pipe friction at any point. Then *B* is the total head against which both pumps will act, and *C* is the head of the new pump. *B* minus *C* is the new head for the present pump, and it must not be greater than the head represented by *FJ* (Fig. 3).

Where pumps are connected in series as in Fig. 1, the larger pump should be located in the line first, discharging into the suction of the smaller. With this arrangement a full supply of water will be assured at all times. If the smaller pump were placed first, it might

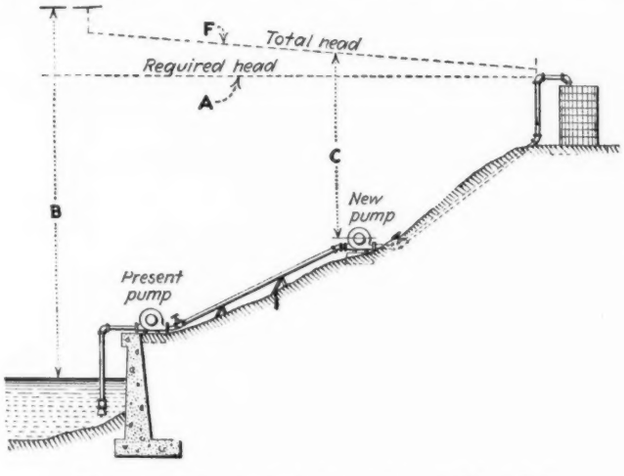


Fig. 7—Two pumps in series and located some distance apart

prove to be an impediment in the suction line of the larger.

In some cases, where the supply is variable, the new pump is arranged for automatic operation. This is a good plan. However, where the connection is parallel, a check valve is required on the automatic pump. Do not put a check valve on the continuous pump, unless its head is at all capacities greater than the intermittent one. If the continuous pump is a lower-head pump than the intermittent, and a check valve is used, the discharge from the small pump will become completely shut off when the intermittent pump starts. The resultant churning will overheat the pump.

From a maintenance point of view, wherever one connection will give practically the same results as the other, the parallel method is preferred. When pumps are connected in this way, it is possible to repair either pump while the other is running. Shutoff valves should be provided for this purpose. With the series arrangement it is necessary to shut down both pumps when either has to be repaired. Of course a bypass pipe can

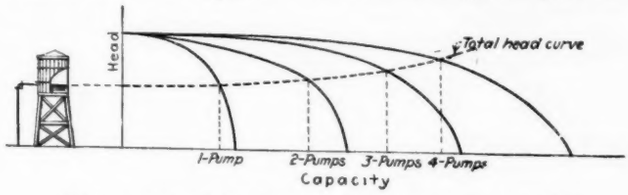


Fig. 8—Combined curves of pumps in parallel

be installed for each pump, but this would usually be considered too expensive.

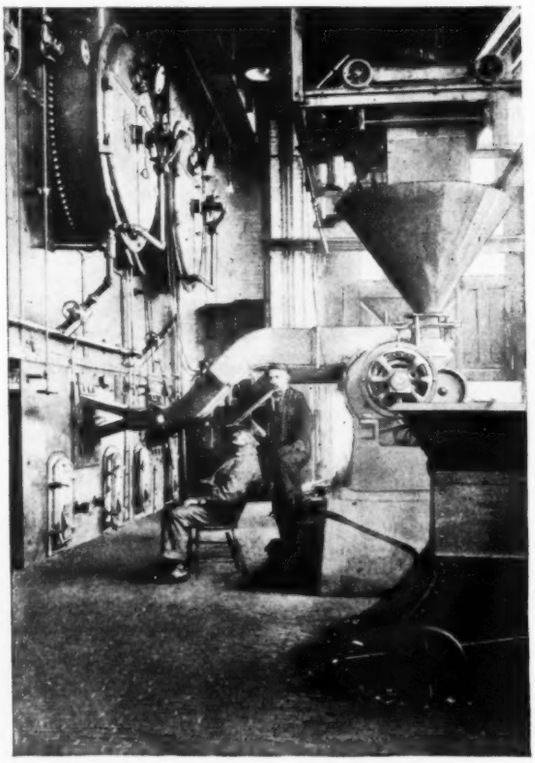
The methods that have been given may be applied to more than two pumps, by first making a composite curve as suggested in Fig. 6, and then using this as though it were a single pump. For new installations, having more than one unit, curves should be plotted to show the composite characteristic of one pump, two pumps, three pumps, etc. A curve of this kind for four pumps connected in parallel is shown in Fig. 8.

A precaution that should always be taken when making any change on the pipe line of a centrifugal pump is to check up on the efficiency at the new conditions. It may be so low as to be very uneconomical, or the motor may be overloaded. This statement relates especially to a pump where another is added in series with it, because all the increased capacity goes through it, and the power requirements are usually increased. Overloading is not so likely with parallel connection.

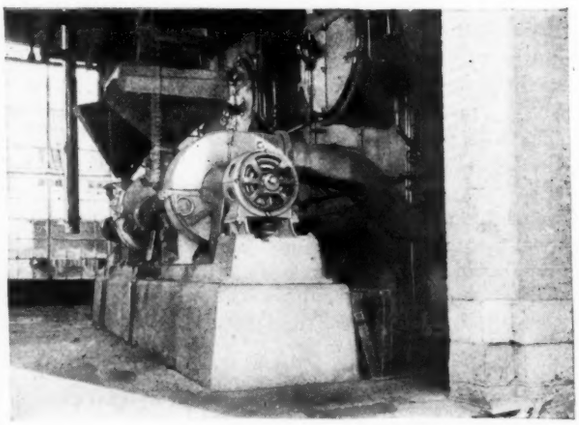
Aside from the advantage of adding a pump to a line already installed, there are several reasons why it is desirable at times to use more than one centrifugal pump on a single line. For instance, where a variable supply is wanted, two small pumps are better than one large one, because each can be used at its most efficient capacity to suit the demand. If the demand is small, one pump can be used, and as the demand increases, others can be started up. Another advantage of more than one unit is that in case of repairs pumping service will be lessened without being entirely discontinued, as would be the case with one large pump.

Again, a pump may be already installed and found not to be adequate at all times. It may be wiser and cheaper to buy another small unit than to replace the present pump with a larger one. The larger pump may be slightly more efficient, but if all the advantages of a duplicate unit are considered, pumping costs may actually be lower by installing another small pump.

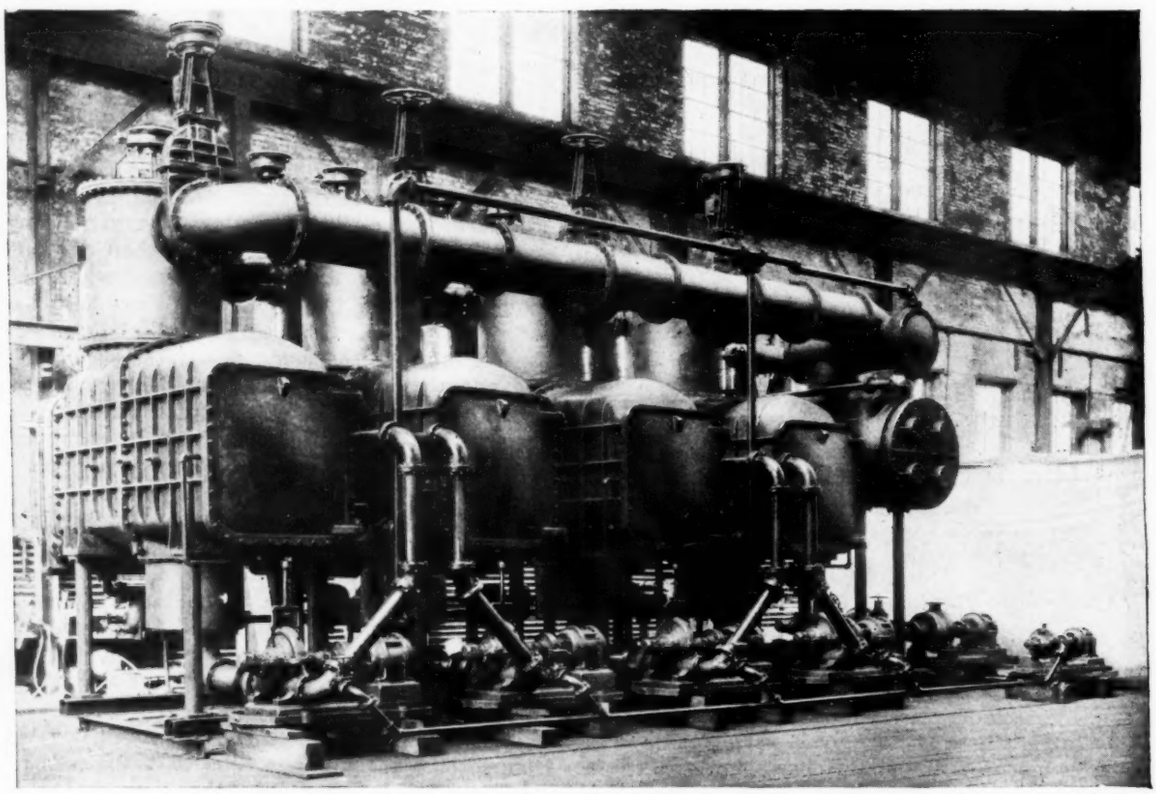
Tests have been made that show that the rate of heat transmission through the tube walls depends upon the velocity of the liquid over the tube surface. These tests were conducted using heaters equipped with straight, smooth surface tubes and also with spirally corrugated tubes. The results showed that the spirally corrugated tubes transmitted more heat in a given time and under identical conditions than did the plain tubes of the same diameter.



Below—The Uxbridge (Mass.) Worsted Co. was one of the first textile plants in New England to adopt pulverized fuel

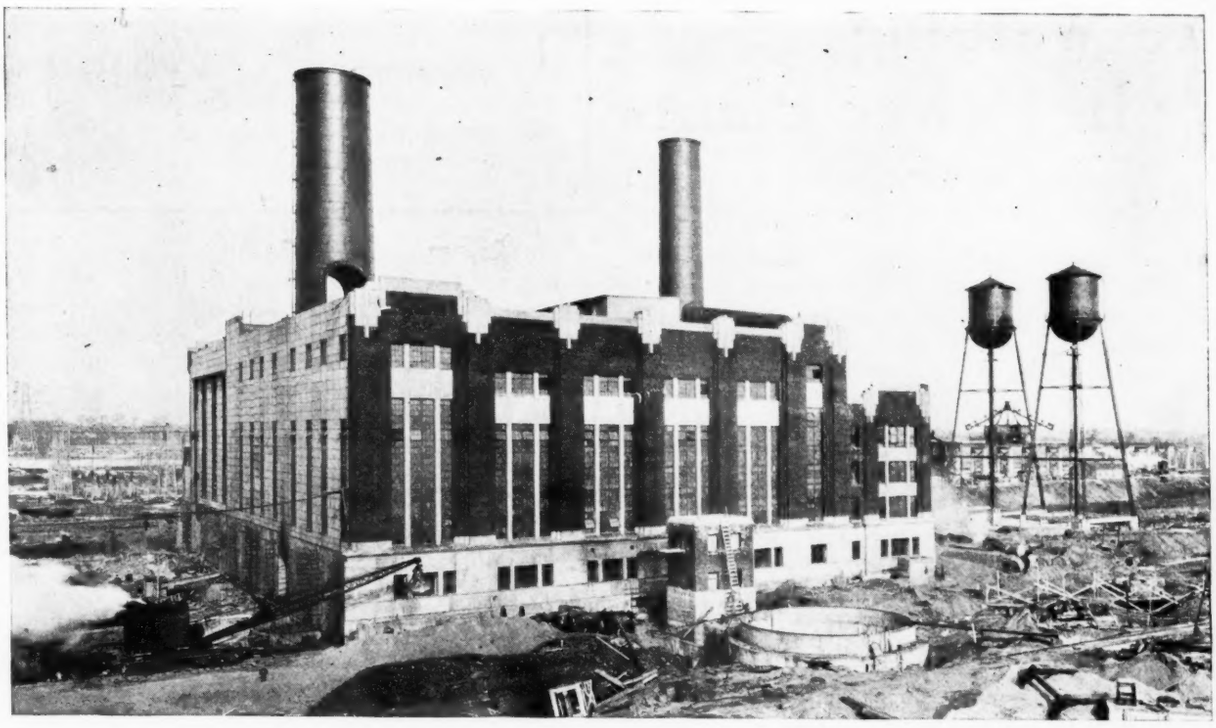


Left—The Uxbridge plant has three horizontal-return-tubular boilers set 10 ft. high. One (rarely used) is hand-fired. The other two are provided with unit pulverizers

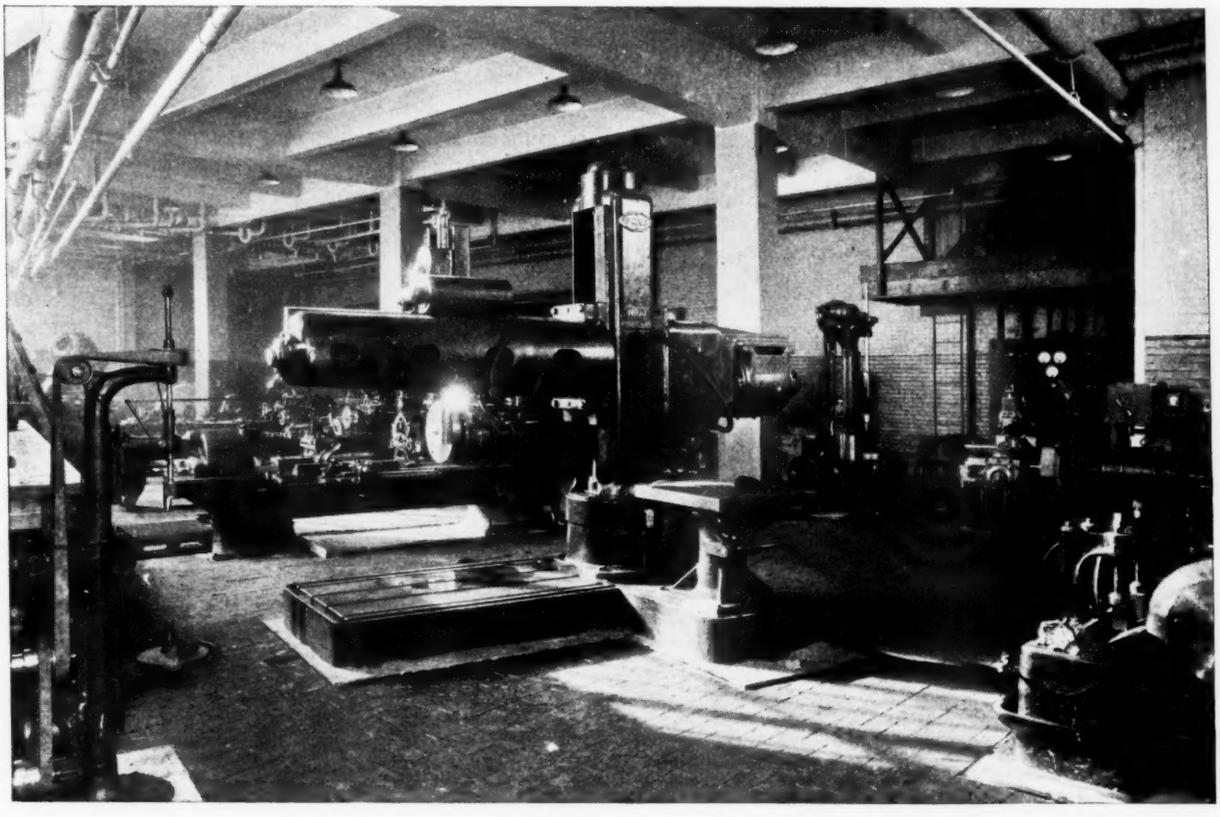


Above—Shop view of film-type evaporator installation at the Philo plant of the Ohio Power Co.

The four evaporators are normally operated in series as a quadruple effect. Once every four hours the direction of flow is reversed through motor-operated valves to reverse the temperature gradient and thus crack off scale. With a normal capacity of 40,000 lb. per hour this is perhaps the world's largest power plant evaporator.



First section of Twin Branch (Indiana) Power Station, a property of the American Gas & Electric Company, nears completion. Two 40,000-kw. units are being installed with reheating and a steam pressure of 550 lb.



General view of machine shop in the Hudson Avenue Station of the Brooklyn Edison Co.

Machinery especially designed for quick repair of station equipment, includes the following motor-driven equipment: One 42-in. by 16-ft. lathe, three smaller lathes, radial drill (5-ft. radius), two smaller drills, planer, two shapers, milling machine, cold saws, grinders and 8-in. pipe-threading machine. All of these machines are of especially sturdy construction.

Arc Welding in Power Plants

By W. L. WARNEP
Industrial Engineering Department, General Electric Company

EXAMPLES are given on applying electric-arc welding in steam and oil engines and hydro-electric power plants, also the application of this method of welding to structual-steel framework.

ELECTRIC-ARC welding, as the name indicates, utilizes the heat generated in an electric arc to fuse metals together. Ordinarily, in the metallic arc process, which is considered in this article, the negative terminal of the arc is called the electrode and consists of a metal rod or wire which is melted by the arc to make the weld on the work, which is the positive terminal of the arc. This condition is called "straight" polarity; the opposite is reversed polarity.

The electric arc melts a small area of the surface of the work-piece. Metal is melted from the end of the electrode and is carried across the arc to be deposited in this molten area. Upon solidification the metal deposited from the electrode becomes a part of the work and forms the weld. Of course the whole cycle of operation is very rapid and is accomplished without the great amount of heat that was necessary in the case of the blacksmith's forge weld.

Repairing Cast-Iron Flywheel

In the applications of electric welding in a power plant, it may be a hydro-electric, a steam, gas or oil-engine plant; in any case there are opportunities for electric-arc welding to effect considerable savings in repair. A flywheel cracks, necessitating a shutdown until repairs can be made. The cracked wheel must

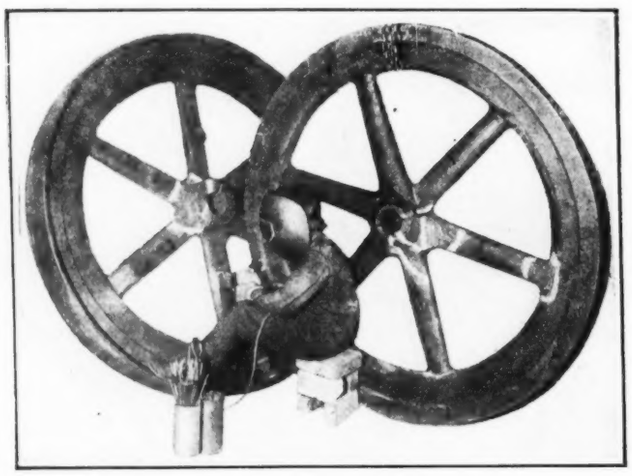


Fig. 1—Repairing two cast-iron flywheels 6 ft. in diameter; white lines indicate welds

be removed and repaired or a new one installed. The quickest and cheapest way is to bring out the portable welding set and repair the wheel by electric-arc welding at a fraction of the cost of a new wheel. An example of a repair of this nature is shown in Fig. 1. These two wheels are 6 ft. in diameter and weigh 1½ tons. The welding consumed 50 lb. of welding electrode, making a total welding cost, including labor and power, of $161.30. New wheels would have cost $1,000 to say nothing of the delay in obtaining them.

Fortunately, crankshafts do not often fail in service, but it is also fortunate that there is available a method of easily and quickly making suitable repairs when such failures do occur. The engine must be dismantled

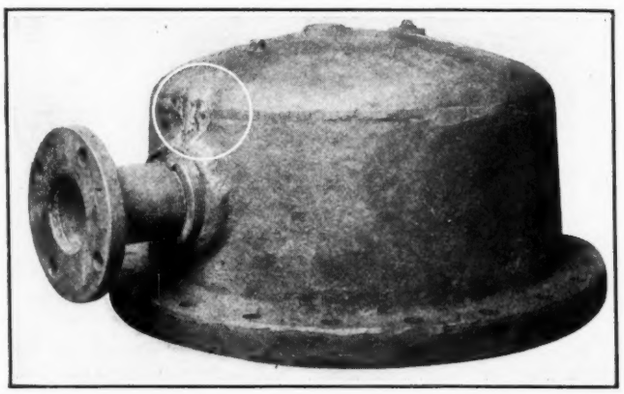


Fig. 2—Cracked cast-iron header for feed-water heater; circle indicates location of crack

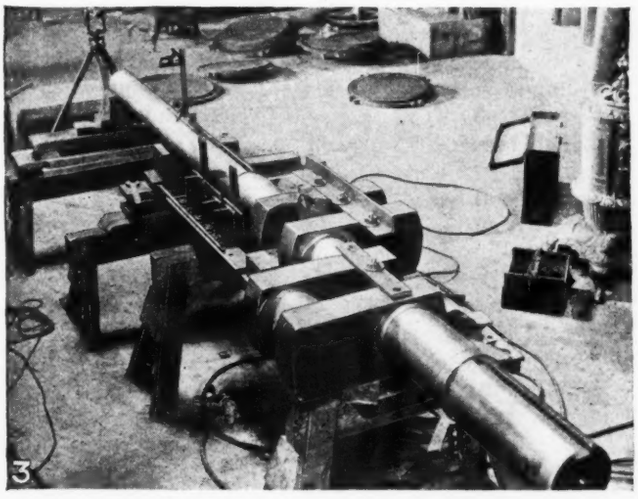
and the crankshaft removed. Careful and accurate alignment is necessary, and generally the break must be beveled, as shown in Fig. 3. In this case great precautions were taken to prevent the weight of the shaft from impairing the alignment.

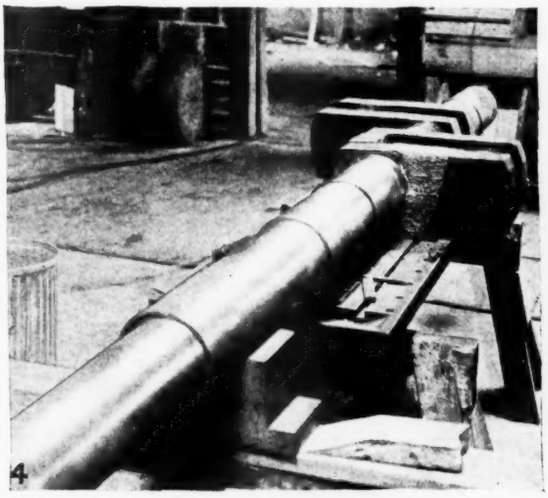
The welding of a fracture of the size shown in Fig. 3 requires caution, as the contraction of the deposited metal on cooling may cause warping unless the clamps are left on until the weld has cooled. In some cases peening the weld metal at intervals, as the metal is deposited, prevents the distortion caused by contraction and increases the strength and ductility of the weld. The finished job is shown in Fig. 4.

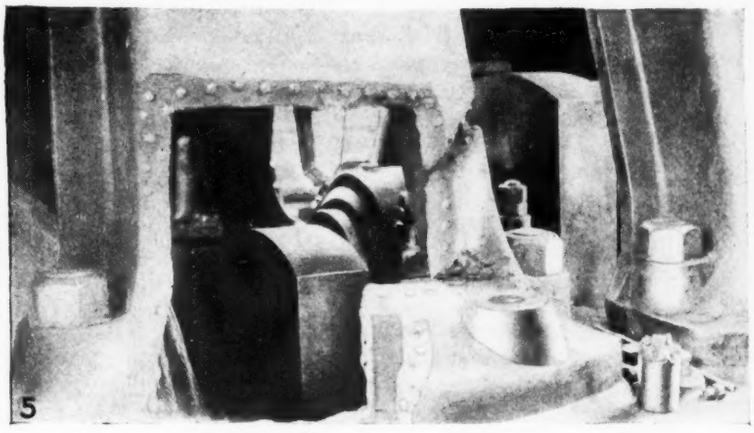
Repairing Feed-Water Heater

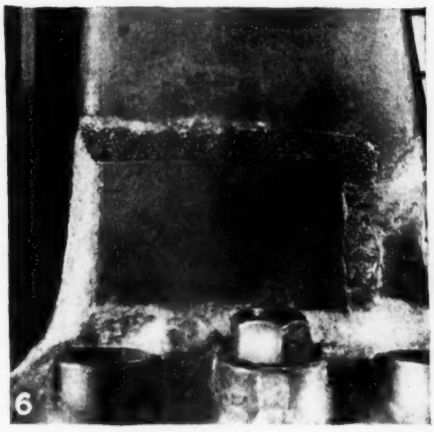
Leaks or cracks in steam or water lines and fixtures can be repaired economically with the electric welding arc. Fig. 2 shows the repair of a cast-iron end of a water heater. A service pressure of 75 to 80 lb. is maintained on the heater, and it has been in service over a year. This fixture is about 2½ ft. in diameter.

A broken engine frame or base may be repaired by the electric arc. In a repair of this nature, where the weld must withstand vibration, a safe practice is to use studs as shown in Figs. 5 and 6. Fig. 5 shows the edges of the broken frame beveled and studded for welding. Fig. 6 shows the old pieces of the break inserted in their proper place and welded. The savings effected in such cases are often sufficient to pay a good share of the first cost of the welding equipment necessary to do the job. These savings include not only the









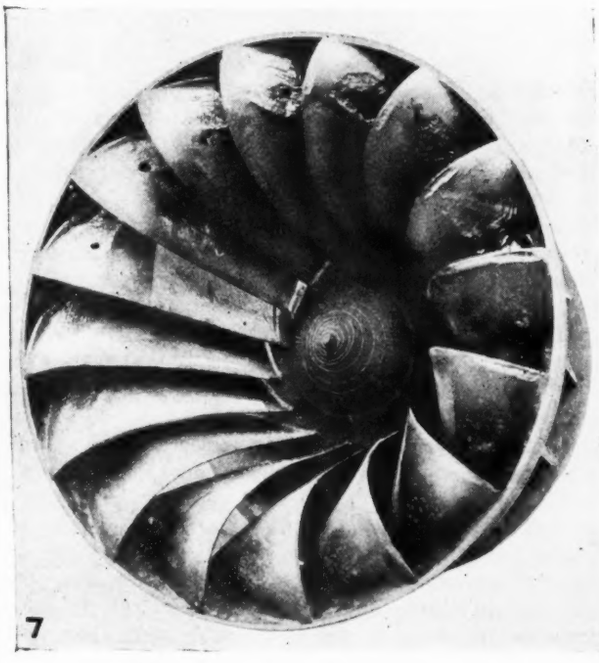


Fig 3 to 8—Before and after making repairs by arc welding

Figs. 3 and 4—Broken crankshaft lined up for repair and after welding. Figs. 5 and 6—Broken cast-iron frame of oil engine prepared for welding and after being repaired. Figs. 7 and 8—Cast-iron hydraulic turbine runner with corroded buckets before and after repairing with electric welding.

cost of a new casting, but also the saving in time obtained by avoiding the work and delay of replacing the damaged part.

In hydro-electric plants the turbine runners or other parts may become seriously eroded, even to the extent that holes may develop in buckets. These holes seriously impair the efficiency of the turbine, and unless repairs can be made a new runner is necessary. Fig. 7 shows a cast-iron turbine runner in which holes have been worn as previously described. This runner was repaired by arc welding. The ragged metal around the holes was chipped out with an air hammer, and ¼-in. steel studs were inserted in the solid metal on the surface which was to be built up with the electric arc. A pad of metal was deposited around the studs and over the holes in each vane. These pads were built up

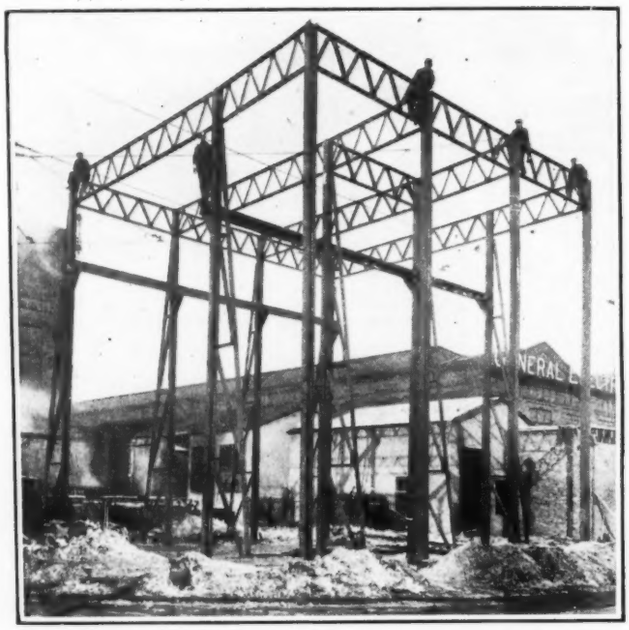


Fig. 9—Welding joints of structural-steel framework for a power service station

thicker than the metal of the vanes themselves and were then ground down to a smooth surface. The completed job is shown in Fig. 8.

Welding Structural-Steel Framework

Thus far we have considered the value of electric-arc welding in relation to the savings obtained in general repair work. Electric welding might also be mentioned where new construction or additions to existing equipment are to be considered.

For example, the building of a penstock or flume of steel with welded joints, the construction of a standpipe or surge tank, or the erection of steel transmission towers are fair instances of welding possibilities. Experience has proved that in structural work great facility is afforded by the welding process. Savings in weight and cost of at least 15 per cent have been obtained on several welded structures. In Fig. 9 is shown a structural framework for outdoor service. About 39,300 lb. of steel was used and the cost of erection was $105.75, while it was estimated that the expense of erecting the same structure by rivets would be about $197.75. These figures do not include the amount of labor saved by eliminating the layout and punching of rivet holes in the shop, the cost of electric power and various other items.

In the case of penstocks or water pipe the welded joint is solid and watertight, and calking is generally eliminated. The writer has in mind an example of how electric-arc welding may save considerable cost and delay. As was the case with the turbine previously mentioned, the draft tube and penstock sometimes develop leaks due to the erosive action of the water. This condition may not be serious, but in order to repair the break, the water must be shut off and the turbine stopped. The ragged metal should be cleaned away around the hole and a steel plate fitted to close the opening. After welding the plate into position firmly over the hole, the turbine may be started again. Contrast the short amount of time necessary to make such a repair by welding as against putting in a new section of pipe. Often the pipe itself is so encased in masonry that the renewal of a section entails a tremendous amount of labor and time.

Electric arc welding is of great assistance in making satisfactory repairs in a power plant. Too much stress cannot be laid on the need for competent welders and careful supervision in all work of this nature. The repair must be made right the first time, or the primary objects of the job will be defeated.

Arc of Contact

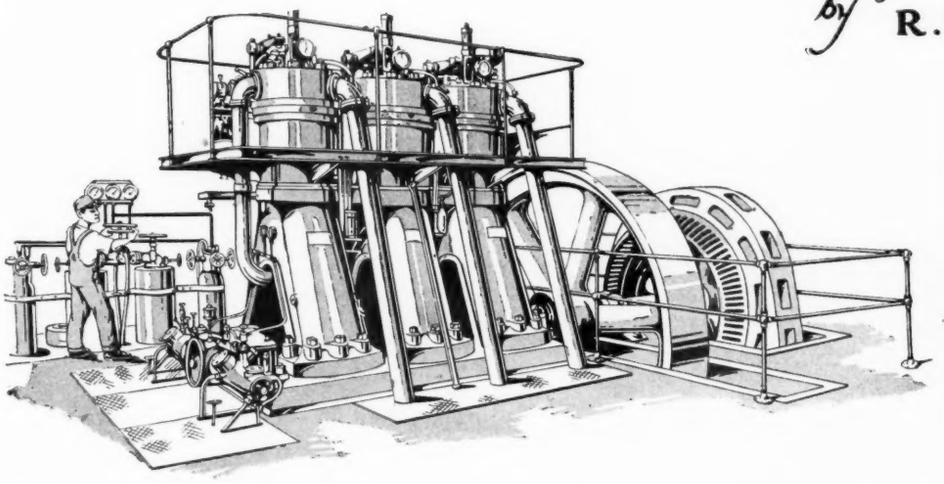
The arc of contact, or angle of wrap, is considered as the angle measured in degrees from the point where the belt comes on the pulley to the point where it leaves. If the driver and driven pulleys are the same size, the arc of contact on each pulley will be approximately 180 deg., or one-half the circumference. Should one pulley be larger than the other, the smaller one will have a wrap less than one-half the circumference and the larger one will have a wrap greater than this.

Many belts have been tested by the Leather Belting Exchange Foundation and it was found that the arc of contact did materially affect a belt's capacity. From this work it was learned that the effect on the horsepower of an arc of contact change was dependent more or less upon the character of the belt surface. That is, a belt with a good frictional surface was less susceptible to arc of contact changes than one with a poor frictional surface. For example, a given change in arc of contact seems to make more difference in transmission capacity with a friction surface rubber belt, which usually has a poor frictional surface, than the same change makes with a high friction leather belt.

Another important fact uncovered by this research is that the arc of contact, as computed for a drive by ordinary geometrical methods, does not check that obtained on the running drive. The accepted method among engineers in designing belt drives has been to make an allowance for the arc of contact based on the geometrical layout of the drive. The difference between the actual angle of wrap and the computed angle depends on the belt speed, belt thickness, belt tension, pulley size, center distance, whether the tight side is above or below, and whether the drive is horizontal or vertical. Since there are so many variable factors affecting the true value of the arc, it is nearly impossible in most cases to predict it accurately, or to compute it.

OPERATION OF DIESEL ENGINES

by R. Hildebrand *



Oil Purifying Systems and Their Advantages

NO MATTER how small the installation a Diesel engine plant should be equipped with some effective apparatus for clarifying the lubricating oil. Much of the trouble experienced with the oil engine is due to the total absence of purifying systems, as is also the high lubricating oil consumption reported from plants having small engines.

An oiling system for a Diesel engine should have some effective means of clarifying the oil circulating through the system. The apparatus used for this purpose may be any of the following: (1) A filter where the oil passes through filtering cloth; (2) a centrifugal oil clarifier; (3) an oil reclaimer, which by means of chemicals breaks the emulsion and thus precipitates effectively the impurities heavier than the oil; (4) settling tanks where the oil remains long enough for the impurities to precipitate and later be drained off from the oil.

There are two types of oil filters on the market. In one type, Fig. 1, the dirty oil enters a filtering bag and the clean oil collects in a chamber below. After these bags have collected a certain amount of impurities, they are removed from the filter together with the dirt collected therein. In the second type the filtering elements consist substantially of hollow perforated frames covered with filtering bags of cotton fabric. These frames are immersed in the dirty-oil compartment, and the oil passes through the bags into the frames, whence it flows into the clean-oil compartment. When these filter elements begin to clog up, they must be removed and cleaned. In doing so some of the muck or sludge is removed from the oiling system; however, the greatest part of the dirt or sludge remains in the filter and must be withdrawn. Thus this type of filter makes it necessary to drain the bottom sediments accumulating in the dirty-oil compartment once a day or once a shift, depending on the nature of the oil. The bottom sediment drawn from the filter contains some valuable lubricating oil and should not be thrown away, but should be saved and the good oil reclaimed by some method. Thus the second type of filter should be used in connection with an oil-reclaiming system in order to operate it economically. With both types described, unfiltered oil may pass into the bearings if some of the filtering bags are torn. For this reason each bag should be carefully inspected after being cleaned and before it is replaced in the filter.

A centrifugal oil clarifier or centrifuge, Fig. 2, is a recommendable machine provided it is given proper attention. Only when properly adjusted to suit the nature of the oil and frequently cleaned, are good results obtained by a centrifuge. It will then remove dirt, grit, water and sludge from the oil although it does not remove the finer carbon particles floating in the oil. Some plants operate their centrifugal oil clarifier continuously. In this case a filter is generally

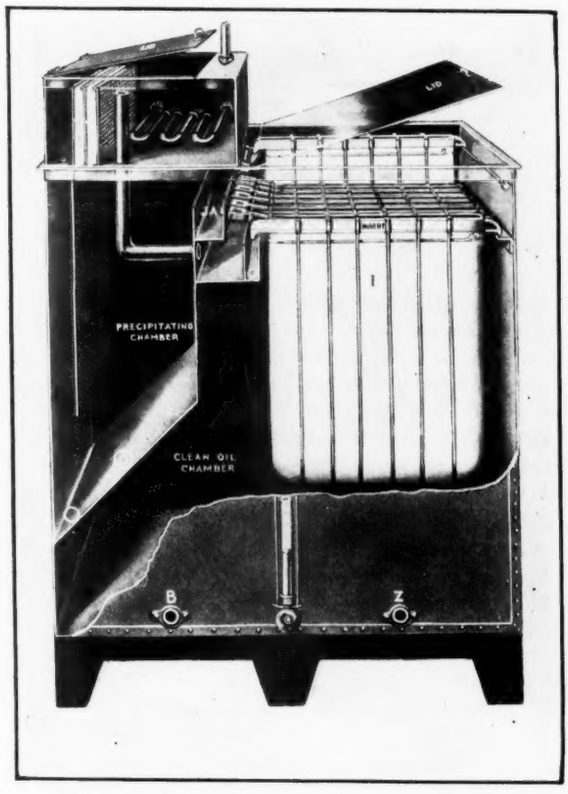


Fig. 1—Filter where dirty oil enters bags

*Chief Engineer, Diesel Division, Fulton Iron Works Co.

omitted and all the oil passes through the clarifier. Other plants use their centrifuge intermittently and in conjunction with a filter if the latter is of the second type mentioned. In this case generally, not filtered oil but oil taken from the bottom of the dirty-oil compartment of the filter passes through the clarifier. The

Fig. 2—Centrifugal removes dirt from oil

combination of an oil filter and a centrifuge makes a good installation.

The so-called oil reclaimer, Fig. 3, works on the "batch" principle; that is, some of the dirty oil and sludge mixture is pumped into the reclaimer where it remains about twelve hours or until the oil becomes purified.

The process of reclaiming is as follows: The oil is first heated by means of steam for about one hour; then certain quantities of inexpensive chemicals are added. These chemicals act as a coagulant to hasten precipitation. The oil is again steamed for about 15 minutes and then allowed to settle for from 10 to 12 hours. The clean oil is now returned to the oiling system, the precipitated dirt and sludge discarded, and a new batch pumped into the reclaimer. It will be seen that this process is based primarily on the settling or precipitation principle. Heat and a coagulant hasten the process. An oil reclaimer is an excellent apparatus to purify contaminated lubricating oil, as it removes not only dirt, grit, water and sludge, but also most of the fine carbon particles floating in the oil. It has also a sweetening effect on the lubricating oil, the chemicals tending to neutralize the acid contained in the oil. It can be used in connection with either the force-feed or gravity-oiling system and will pay for itself in a few months.

The reclaiming or purifying of the oil by settling tanks is simple, cheap and effective. The benefit derived from merely letting the oil come to a complete rest for several days or for a week is generally not fully realized.

To settle this matter for himself the engineer or the owner of the plant should make the following experiment: Fill a pint bottle with very dirty oil from the bottom of an oil filter or from the sump tank if the oiling system is provided with such a tank. Shake the oil vigorously and pour half of it into another pint bottle. The quality of the oil in both bottles is then alike. One of the bottles, we will call it the first bottle, is kept for later reference. Place the second bottle in a warm place and let it stand for about a week. The time required to precipitate all impurities contained in the oil will depend on the temperature. If convenient keep the oil heated to about 160 to 180 deg. F. At the end of the week pour the clean oil into a third bottle, leaving the precipitants in the second bottle. Now take the first and third bottle, shake them well and observe the difference in the oil. Note how clean the reclaimed oil in the third bottle is compared with the dirty oil in the first bottle. Also compare the oil in the third bottle with new oil and observe that both are very similar with the exception of the color. Compare

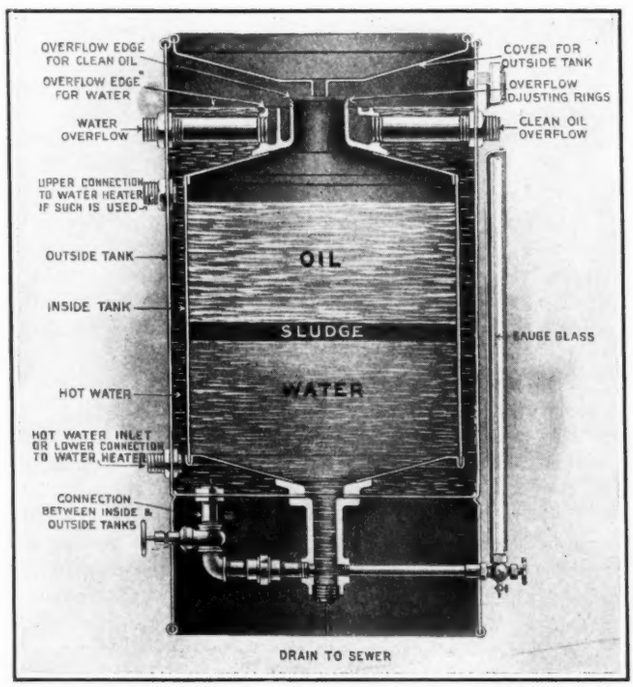


Fig. 3—Chemical oil reclaimer sweetens the treated oil

the oil in the third bottle with the same oil after passing it through a centrifugal oil clarifier or through an oil reclaimer and observe that it is not wanting. This should not be surprising because in these three methods of oil purification, centrifugal oil clarifier, oil reclaimer and settling tanks, the reclaiming is based on the same process; that is, the separation of the oil and its impurities according to the specific gravities of the several substances.

[This is the fourth of a series of practical articles on oil-engine operation. Others appeared in *Power* Jan. 20, Feb. 3, Feb. 17—Editor.]

The Broadening Recognition of Fuel Engineering

THE remarkable growth of technology has resulted in the continued development of subdivisions into major branches of engineering. Civil engineering once included mechanical and electrical. Then mechanical engineering split off as a separate profession, with electrical engineering under its wing as a subdivision. Concrete evidence of this may be found in the Dewey decimal filing system, whose engineering section, prepared not so many years ago, definitely catalogs electrical engineering as a subdivision of mechanical. Fuel engineering, which was formerly the joint ward of mechanical and chemical engineering, is one of the latest subdivisions to gain recognition as a distinct profession.

Evidence of this fact, if any were needed, could be found in the action of the Massachusetts Institute of Technology in founding a complete graduate course in the subject, to start October next. As outlined by Professors Haslam and Ward in the February issue of the *Tech Engineering News*, this course will include instruction in the following subjects: Gas engineering, fuels, combustion, furnace design, development and use of power, power plant design, internal-combustion engines, economic geology, gas economics, etc.

The scheme of instruction is even more interesting than the subject matter of the curriculum. Instead of mixing classroom and laboratory work in the usual manner, the course will consist of an academic year devoted to classroom work followed by six months' experimental work in industrial plants. This insures experience in putting theory into practice and shows a recognition by the faculty of the impossibility of reproducing practical combustion problems on a laboratory scale.

During the period of field work the student will receive no pay from the company where the work is under way and thus can concentrate all his energies on his own self-development. In this way the experience gained in six months should far exceed that obtainable in a like period of ordinary employment, where the necessities of the job often tend toward a one-sided training. While other educational institutions have tried the experiment of placing their students in an industrial environment for fixed periods, educational efficiency has in some cases been sacrificed to the necessity on the part of the student of rendering service for pay received.

The course as outlined leads to the master's degree. Students of promise will be encouraged to continue their work for the doctor's degree.

Chemical engineering is already greatly indebted to "M.I.T." for its contribution of highly trained men to that field. The application of similar methods of training to the field of gas and fuel engineering should do much to improve the efficiency of American industry and conserve our invaluable fuel resources.

The College Graduate and His Job

THE time of year is approaching when hundreds of seniors in mechanical engineering are thinking about the jobs they will take up after graduation next June. Many have no definite idea of what they want to take up except that they wish to reach executive positions as soon as possible and with as little effort as necessary. They often do not realize that one in an executive position must have that intimate knowledge of the business that can be secured only by actual experience in its every phase and by long years of patient work as a subordinate; otherwise they would give more consideration to the subordinate positions.

What characteristics does the employer desire in the young graduate that he would add to his organization? Naturally he wants a man of agreeable personality with a good physique and of cheerful disposition. The Mann report of the Carnegie Foundation some years ago indicated that the other qualifications desired, stated in the order of their desirability, were as follows: (1) Character, (2) judgment, (3) efficiency, (4) understanding of men, (5) knowledge, and (6) technique. In studying this list one cannot help being impressed with two facts; first, that those qualifications most stressed in college are placed at the bottom of the list and, second, that the personality of the man as indicated by the first four characteristics is given first place.

When a young man applies for a job, he should therefore make an inventory of his relative value in these characteristics and present this to the man who would employ him. If he seems of the right sort, his college records will be given only small consideration. What, then, is the value of the college courses? Merely as a means of developing other latent abilities that may lie in the student and of teaching him to think straight and reason to accurate conclusions.

How can the student evaluate the job for which he may be applying or which may be offered to him? This is often a difficult matter, for he must consider his future prospects with this concern. College students should be impressed with the fact that their value to any organization is a replacement value only. In other words, their compensation will depend on the ability of the organization to replace them at will. Hence, any position that permits a graduate to apply at once at a relatively good salary his technical knowledge acquired while in college, is one of questionable value. Next year, when he wants a raise in pay, it will not be forthcoming for he can be easily replaced by a man from next year's graduating class. On the other hand, a man who enters the employ of a company which puts him at some expense to that company, through a long course of training extending over several years, becomes an asset of increasing value during all that time. He can be replaced only by a man who has also been given this long training. Furthermore, the company will wish

to earn good returns in later years from their expenditures in giving him this costly experience. This type of job is by far the more preferable to the average college man.

What are the opportunities in the power field? Many new stations have been built in recent years, and many more must be built to carry our increasing power loads. These stations employ higher pressures and operate on more refined cycles than the older plants. Their operation calls for an extended technical training and therefore offers opportunities for the college graduate. On the other hand, modern plant operators must have a wide practical experience so that they can meet and handle any emergency that may arise. This calls for years of training in subordinate positions in the boiler, turbine and electrical sections. Such work may be dirty at times and the hours long, but a fund of rich experience is being gathered which increases one's value to the company.

A position with one of the large power concerns thus falls in the second class of job as discussed herein and hence is one of the desirable openings for college graduates. One who likes machinery, can handle men and knows his thermodynamics should give careful consideration to the great opportunities in the power field and to such training courses as will make it possible for him to achieve leadership in this line of endeavor.

Niagara Falls' Latest Power Development

MOST important water-power sites are located where, outside of the natural contours and formations of the surrounding country, few limitations are placed upon the engineer as to how the development shall be made, so that considerations are chiefly those that will result in the most economical development.

At Niagara Falls, right at the power site on the American side, is a town of over fifty thousand people, the best interests of which must be considered in any development. In addition to this are the state and national interests in the scenic beauty not only of the Falls, but also of the adjoining parks. These restrictions have produced some interesting engineering problems in the latest developments made by the Niagara Falls Power Company and described in the leading article of this issue.

From beginning to end of this undertaking it has been a case of pitting sound engineering against space restrictions. The water is carried to the new plant in a tunnel that far exceeds in cross-sectional dimensions anything previously attempted. This method was not adopted for the purpose of constructing the largest power tunnel in the world, but for sound economic reasons, due largely to restrictions on the ground surface. The intake to this tunnel is between the hydraulic canal intake and a public park. This intake probably would have been made larger and of a somewhat different form if the engineers had been unrestricted in their choice.

The forebay to the tunnel is made to fit in between the hydraulic canal, the canal basin and a trunk-line railway on a piece of property of very limited dimensions, but this was all that was available, so again engineering had to provide a solution. The restrictions resulted in having to drive the penstocks under the canal forebay, which made it necessary to place the intakes farther under water than probably has ever before been done. To provide valves at the top ends of the penstocks, restrictions required that they be placed in the penstock's mouth instead of in the penstock proper, and butterfly valves, the largest ever constructed, have been installed.

When it came to choosing the size of the units, it was found that in the space available the power to be developed could be installed in three machines of seventy thousand horsepower each. Smaller units might have been selected if the engineers had been given a free hand in the matter, but as it was, space limitations required that the largest hydro-electric power generating units ever attempted be built and installed. So it has been from one end of the development to the other, space restrictions determine the problem to be solved, and these could be met only by building the largest power waterways and equipment ever attempted. Great credit is due to the power company's engineers as well as those of the manufacturing companies, who in spite of all the restrictions have produced one of the most efficient power developments ever made.

Time To Call a Halt

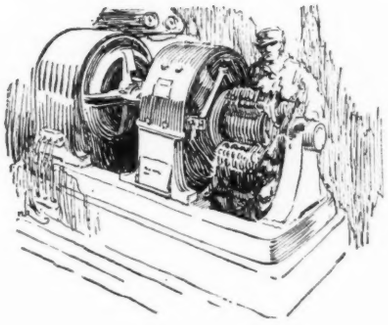
IN THE United States the crude-oil resources are being drawn upon to supply about three-quarters of a billion barrels a year. These figures, however, do not tell the whole story, since it has been estimated that no more than one-quarter of the oil in the ground is brought to the surface by present methods. If this is correct and unless the abandoned wells are worked at some future date, we are using up our oil supply at a rate of three billion barrels a year.

There have been various estimates of our oil resources, but according to the latest figures of the United States Geologocal Survey, these resources, if the present rate of consumption continues, should be exhausted in about ten years. It is doubtful if conditions are as serious as these figures would indicate, but the rate at which we are drawing upon these resources is such as to bring early exhaustion, even if the reserves are two or three times the present estimate.

Although from within the oil industry come reports that all is well and that there is no need of alarm for many years to come, the exhausted state of our natural-gas resources is a solemn reminder of what may happen to oil. It is true, as J. Edgar Pew, president of the American Petroleum Institute has said, that "the oil industry has in a big way accomplished the seemingly impossible in the amount of oil produced, notwithstanding repeated prediction to the contrary that there were no such amounts of oil to be had." This, however, is no reason why we can expect the industry to continue to do so, even though its chief spokesman may so predict.

Our oil supply is of too great importance in the industrial development of this country and in our national defense to be gambled with. The recent appointment of an oil conservation board by President Coolidge was one of the most important steps so far taken to prevent waste of our national resources. An industry that has been allowed to run riot for so many years naturally will not take kindly to having its methods and practices viewed by a governmental body, but the time has come to call a halt on the waste in the oil industry, and the character of the commission is an assurance that the whole matter will be considered with thoroughness.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. Three prominent operating engineers have been invited to act as judges. The winners for January will be announced this month.

Small Boiler Explosion Emphasizes Need for Supervision

A short time ago a boiler explosion occurred in the plant of the Keokuk Nickel Plating Co., Keokuk, Iowa, which should serve as a warning to others who may contemplate the installation of similar low-duty boilers and who might be inclined to underestimate the importance of proper care and a reasonable degree of safety in such work.

The accident happened about 10 a.m., but as the plant employs but a few men, all were absent from the immediate vicinity of the boiler when the explosion occurred, so no one was injured. The boiler was a small home-made affair used for heating water for the nickel-plating processes, the shell being of ¾-in. steel and approximately 24x48 in. over all. To all appearances it had been an internally fired vertical boiler and had been reworked by some local mechanic. The original firebox door had been closed by a plate welded and bolted in place. Another plate had been welded over the lower end of the shell to close the opening left by the removal of the original firebox and mud ring. A 10-in. flue extending through both heads completed the outfit, which was set upon an improvised firebox. No evidence of a safety valve could be found, and the acetylene welding of all joints was of a very poor character. The accident was no doubt caused by over-pressure on a pitifully weak job of boiler work, probably helped along by the absence of a pop valve or pressure gage, possibly also by heavy firing or low water.

The boiler was torn from its foundations in the basement, thrown through the first floor, tearing a hole about 30 ft. square in it, then on through the roof, where another hole about 20 ft. square was torn out, finally coming to rest at a point about 100 ft. from its foundation. The upper seam or joint of the flue and the joint where the lower end plate was attached to the bottom of the shell must have failed practically simultaneously, as both were torn from the shell and left behind it in the building.

It is said that the owners of the outfit were formerly stock raisers and that the apparatus had been used as a feed cooker on a near-by farm. Be that as it may, certainly there was gross carelessness in choice of equipment and necessary accessories, in the poor workmanship employed, and very likely in methods of operation. The evidence shows a heavy explosion, doing more damage than would be deemed possible until shown by such an experience, and failing of fatal consequences only because the immediate neighborhood happened to be deserted. This is the more remarkable when it is noted that the boiler in its flight, missed an ordinarily heavily traveled highway bridge by only a few feet. The whole occurrence emphasizes keenly the well-known fact that even small boilers though seeming comparatively harmless, need intelligent and rigorous supervision in their building, installation and operation.

Keokuk, Iowa. H. B. McDERMID.

Emergency Pulley Repair Job

A few years back I was in charge of a mine in New Mexico, having three large drifts. As usual, the most important piece of machinery was the exhaust fan at each drift, which must be kept in constant operation day and night. When it was found necessary to shut down a fan for any length of time, the men were called out of the mine as a safety precaution. The fans were inspected twice each day, and at night the watchman visited each fan every two hours.

One morning at 7 o'clock the watchman called me, stating that the fan at No. 2 mine was not running. Upon investigation it was found that the large pulley on the fan shaft had slipped off and was broken beyond repair. As it would take at least a week to get another one and there was no pulley at the mine anywhere near the size required, it was up to me to do something. There were available several large empty reels that cable and heavy wire had come on. Two of these reels were found to be within an inch of the same diameter as the broken pulley, also the center hole was only about one-half inch smaller than the fan shaft. The four sides of the two reels were bolted together, which made a pulley face approximately 9 in. wide. Ordinary building laths were then nailed all around the circumference of the pulley. This put a reasonably smooth face on it and at the same time increased the diameter to approximately that of the broken pulley. With a half-round wood rasp the center hole was enlarged to fit the shaft, also a keyway was cut.

After this emergency pulley was put on the fan, it was found to run fairly true and the belt rode it in good shape. The fan was running by 7 o'clock, and as the time for the men to go into the mine was 6:30, it was only necessary to hold them outside for an hour. It was over two months before a new pulley was received for the fan, and during that time no trouble was experienced with the makeshift pulley.

San Bernardino, Calif. FRANK HUSKINSON.

Water Supply to Ammonia Condensers

Designers and erectors of refrigeration plants often fail to realize the importance and necessity of an ample and uninterrupted source of water supply for the ammonia condensers, as evidenced by the condition of many plants throughout the country.

I was once employed as engineer of a refrigeration plant of 200 tons capacity. The ammonia condensers were of atmospheric type situated on the roof of a four-story building. At one end of the building the water-cooling tower was located, with its basin for water reservoir on the ground level. The cooled water was taken from this reservoir by a motor-driven centrifugal pump and forced upward to the roof and over the atmospheric condensers.

When I took the position as engineer, the operating conditions were annoying, to say the least. In a system of this kind there is always a certain amount of water lost through evaporation and other causes. In this case there was a great amount lost through drifting, that is, the wind blowing the fine spray of water outside the confines of the reservoir, which was exactly the same dimensions as the water tower. Makeup water was supplied to the reservoir from the city mains at 60 lb. pressure. At this time the only way of regulating the amount of makeup water to the reservoir was by a manually operated globe valve. The operating engineers were usually busy tending some other part of the plant, and occasionally the water level in the reservoir would get down below the suction line of the centrifugal pump that supplied the cooling water.

One night a new operating engineer was on the night shift. He failed to keep an eye on the water level in the reservoir, and the circulating pump lost its suction. He failed to keep a close watch on the high-pressure ammonia gage, and the pressure increased until a gasket blew out on the condensers on the roof. He didn't realize what had happened until he had practically lost a complete ammonia charge, worth hundreds of dollars.

As the compressors were all motor-driven, a recurrence of this trouble was easily prevented by equipping the motors with an automatic pressure switch whereby the motor switches are automatically opened when an overpressure occurs on the high-pressure ammonia lines. We also placed a balanced float valve on the makeup water line to the reservoir.

On another occasion during the hot summer months the motor on the condenser circulating pump burned out. There was no auxiliary pump in the plant for supplying this water, so we hastened to the roof to open the valve connected to the city mains, which was supposed to be used in just such an emergency. We opened this valve, but were surprised to find that the water pressure was too slow to lift the water to the top of the condensers. This meant a complete shutdown of the refrigeration plant when it was most needed. We were unable to secure a new or used motor in town of the same size or dimensions that would fit on the pump foundations. Therefore, we were compelled to rig up an improvised belt drive with another motor.

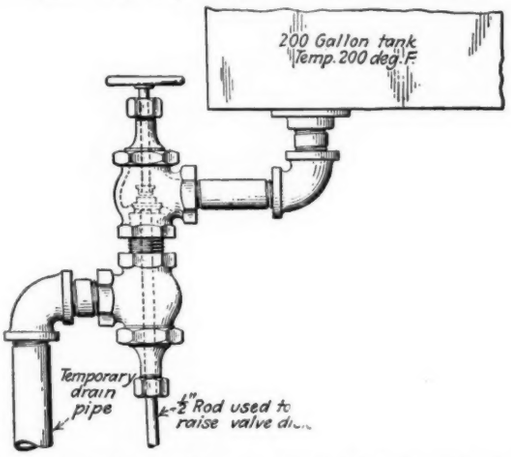
The management finally awoke to the condition in the plant, and we purchased a small steam-turbine driven pump as an auxiliary. Steam drive was selected for the reason that we were purchasing power from a utilities company and we had found that its service was not altogether infallible. Making these few improvements relieved the operating engineers of a lot of worry and inconvenience, and the small investment returned large dividends in improved service. ROLAND TULLIS.

Monrovia, Calif.

How Valve Was Opened After Disk Became Free from Stem

Recently in attempting to open the drain valve on a gasoline still the disk became free from the stem, and as the pressure was on top of the disk some other means of opening the valve had to be found.

After some discussion we decided to disconnect the drain line and screw another angle valve on the outlet with a ½-in. rod replacing the stem as shown. By



Disk was raised with a rod placed through stuffing box of a second valve

connecting the drain temporarily to the outlet of the second valve and pushing up the rod, the disk was lifted from its seat and the tank emptied without loss of liquid. The valve was then repaired and replaced on the pipe with the pressure under the disk to obviate further trouble from this cause. C. J. COVEY.

Utica, N. Y.

His Suggestion Was a Good One

Some time ago I was given the job of drilling holes in the ends of some second-hand rails that had been ordered to repair a narrow-gage track in the yard adjacent to the plant. Not having done this kind of a job before, I started at it with the ordinary hand ratchet and twist drill, as our equipment for this class of work was somewhat limited.

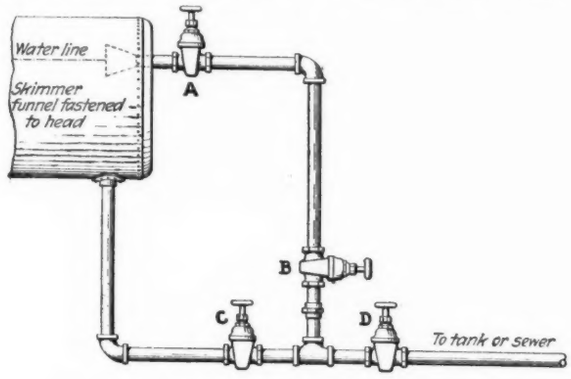
I had not made much headway with the drilling when the chief came around to help me. About the same time a man stepped to the door and asked the chief if he could look through the plant, and the chief gave him permission. After looking around for a while, he came to where we were working. He at once suggested that if we would sharpen the drill and then use turpentine for a lubricant we could drill the holes with ease. This made the chief angry and he told the man to leave the plant immediately, which he did. After he was gone, I followed his suggestion and drilled the holes easily. Since then I have used turpentine on hand drilling with high-speed drills and have found it better than oil in many cases. GEORGE A. SHIPE.

Santa Ana, Calif.

Blowoff Connection That Keeps Pipes Clean

Not infrequently, we hear engineers citing their troubles with stopped up blowoff pipes. The illustration shows a skimmer and blowoff connection that we have used, which has entirely eliminated this trouble.

When the boiler is in normal operation, we keep the valves *A*, *B* and *C* open, and a circulation is set up



Arrangement of blowoff and skimmer connections

through the skimmer and blowoff pipe, thus tending to keep the pipe clear.

When blowing down the boiler, the valves *B* and *C* are first closed and the valve *D* opened, then the skimming and blowdown are regulated by the valves *B* and *C*. This prevents any wiredrawing action on the valve *D*, and it stays tight for long periods. With a 2½-in. blowoff line the skimmer connection should be 1½ in. or larger.

L. L. SCHEIDERER.

Toledo, Ohio.

Ways of Saving in Ice Plants

Last summer we tried out a number of schemes to lower the cost of ice production and improve the efficiency of the plant. Our efforts may be of interest to other ice-plant engineers.

We first tried to use the water sucked from the cores as cooling water for the ammonia condensers. This seemed to lower the condensing pressure somewhat, so we next put all broken ice and small pieces swept from the storeroom floor into the overflow compartment of the dip tank. The overflow from the dip tank was then piped to the sump from which the condenser pump gets its water. This has lowered the condensing pressure somewhat and also furnished sufficient makeup water to take the place of what is evaporated and blown away from the cooling tower. Water alone is quite an expensive item when it is pumped from a well 350 ft. deep or bought from the local water company at a price of $2.50 per thousand gallons.

We have tried a number of more or less expensive chemical compounds to stop the growth of moss or vegetable matter on the condenser and in the cooling towers. None was entirely successful until we tried using the strong limewater that comes from the blowdown of our water softener. Ten or fifteen gallons of this limewater is mixed daily with the condenser water and is keeping the vegetable growth down. After six months' use there is no undue tendency to scale, and all the vegetable growth has been cleaned from both the condenser and the cooling tower.

Formerly, we threw all the oil away that was blown from the oil traps, cleaned out of crankcases of inclosed compressors, taken from ring or chain-oiled bearings or from any of the many places where it is necessary to change the oil periodically. Now we save all this oil, and after the dirt and water have been filtered out, we find use for it. In the course of a year we save several barrels of oil in this way.

These methods of cutting operating costs may seem rather small business to some engineers, but we save a good many dollars every year by just such methods as these and we believe the management appreciates these small economies.

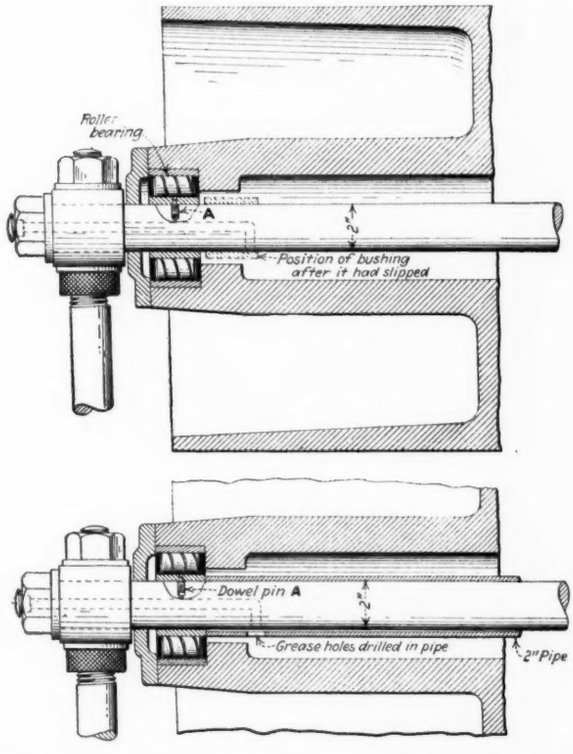
B. C. WEAVER.

Napa, Calif.

Improvement on an Idler Pulley

The illustration shows how we remedied a trouble with the inner bushing of a roller bearing on an idler pulley, which slipped on the shaft and allowed the rollers of the bearing to drop on the shaft.

When the bearing was assembled, the inner bushing was designed to be held in place by an inside setscrew pin *A*, which would be screwed into the shaft until the



Placing pipe over shaft prevents bushing from slipping

top of the pin was below the surface. Then the bushing would be driven on the shaft until a hole in it was directly over the pin. Then with a screwdriver the pin would be backed up into the hole of the bushing until the threads shouldered against the inside of the bushing. This would prevent the pin from coming out into the path of the rollers.

These pins however, in time, would work down into the shaft below the inner face of the bushing. Then the end thrust and vibration caused the bushing to work along the shaft from under the rollers, letting the rollers down onto the shaft. After this had happened twice, we fitted a piece of 2-in. pipe on the shaft

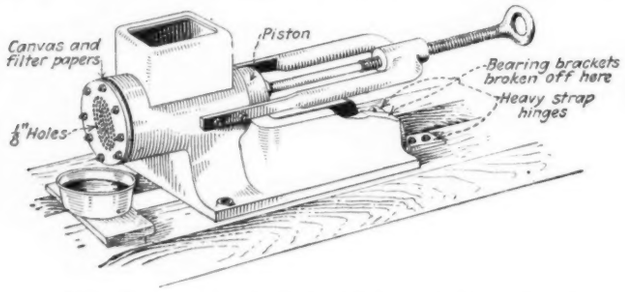
between the bearing bushings as shown in the lower view. This eliminated any chance of the bushings slipping.

L. M. JOHNSON.

Sewickley, Pa.

Filter Press Made from a Gas Engine

A powerful and efficient filter press, which is suitable for extracting waxes from oils and for other purposes about the laboratory or experimental plant, and which allows the use of a chilling medium in the press, can



How gas engine was changed to a filter press

be made from a discarded gasoline engine, as shown in the sketch.

The particular one shown herewith was made from an old 3-hp. portable engine. The crankshaft bearings were broken off and a yoke bolted to the front of the cylinder as shown, the yoke used being half of a large turnbuckle. A long screw passing through the nut part of the yoke served to thrust back the piston. The piston was filled with babbitt and carried a 1-in. pipe cap against which the end of the screw bore. Hinges attached to the end of the frame allowed the apparatus to be turned to a vertical position for filling.

The regular cylinder head was discarded and a new head made of ½-in. steel plate pierced with ⅛-in. holes. Back of this was placed heavy canvas and then the desired amount of filter papers.

In operation the apparatus is turned to a vertical position, and with the piston at the extreme forward position. The material to be filtered is put into the cylinder. Then the filter papers, canvas and cylinder head are bolted in place, and the apparatus is lowered to a horizontal position. A dish is placed under the head to catch the liquid filtered through. If chilling of the material is desired, the cooling-water reservoir is filled with cracked ice and salt.

Turning the screw up with a lever filters the material rapidly and efficiently. No trouble has ever been experienced by leakage past the piston rings.

The press described in the foregoing is capable of giving pressures as high as are likely to be required of any extemporized apparatus. In actual practice it is cheap and satisfactory.

A similar press can be made, which does not require the wrecking of an engine. Simply remove the connecting rod and crank and in place of the crankshaft put a straight iron bar, clamping it in the bearings. Fill the piston with a block of wood and use an ordinary screw-jack to force the piston back. Filtration is through a perforated plate and filter papers as previously described. The pressures obtainable will not be equal to those in the press illustrated, but for many purposes it will be found amply satisfactory.

Casmalia, Calif. V. A. LYMAN.

Inserting Piston Rings and Tramming Piston Rod on Unaflow Engine

In an article in the Nov. 25 issue of *Power*, I described the methods of putting rings on the piston of a unaflow engine. The illustration herewith shows the method used to contract the rings when starting the piston into the cylinder and also how the adjustments are made to keep the piston central in the cylinder.

Fig. 1 is a view of the piston ring having a semicircular oil groove on its outer surface, shown at *A*. The rings are ⅝ in. square in cross-section and 24 in. in diameter. To facilitate the entering of the rings into the cylinder, we made a pair of tongs from ⅜x1-in. flat iron as shown. Fastened to the short end of the tongs is a wire loop of sufficient length to span the ring nicely. In starting the rings into the cylinder, the loop is placed over the ring and the handles pulled together. This contracts the ring sufficiently to let it enter the cylinder easily. Care must be taken to prevent the wire from being caught when entering the ring. After the ring is started into the cylinder, the tongs are released and passed back to the next ring.

This particular make of engine has a floating piston, the weight being suspended from the crosshead and tail slides. The manufacturer furnishes with each engine two tram gages to test the setting of the piston rod on the crank and head ends of the cylinder. These tram gages are dropped through spot-faced holes in the casting, as shown in Fig. 2, and the clearance between the end of the tram gage and the top of the piston rod indicates the wear on the slides. On the crosshead end the wear is taken up by adjusting the crosshead shoes

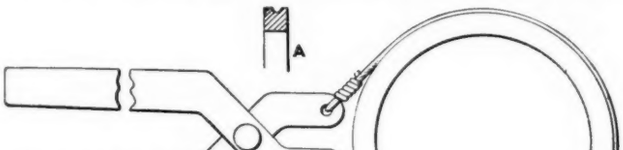


Fig. 1

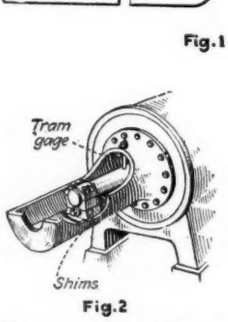


Fig. 2

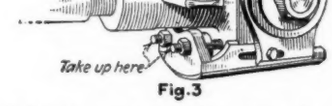


Fig. 3

Figs. 1 to 3—How piston ring is contracted and piston adjusted centrally in cylinder

as shown in Fig. 3, and on the tail slide more shims are added from time to time. In tramming the piston rod, we always place the piston on the center of the stroke.

Cincinnati, Ohio. A. A. FETTE.

Greasy or muddy deposits may be removed from the tubes of a water heater by the use of a solution made by adding one pound of caustic soda to ten gallons of water. The solution should be circulated through the heater, the latter being thoroughly flushed out before it is again put into service.

Comments from Readers

Gasket Compound Made of Coal Soot and Cylinder Oil

It occurred to me that readers of *Power* might be interested in hearing of a home-made compound that we use on gaskets of all kinds including boiler manhole and pipe joints. The compound is made by mixing cylinder oil and coal soot to the consistency of a heavy paste.

We have used this compound on boiler manhole gaskets for three years and have never renewed them in that time. It has been our experience that the joints do not seep as was frequently the case when graphite was used. S. BARTHOLOMEW.

Manchester, Ohio.

Removing Scale from Jacket of Diesel Engine

The answer given to the inquiry of H. S. L. in the Jan. 27 issue is very good, only I would not dilute the acid at all. We have had many years' experience along this line and have found we could get better and quicker action with the undiluted acid. Our method is to drain the water out, close the drain and pour the acid in at the highest point in the cylinder. The opening for pouring in the acid should be of considerable size, or two such openings are better, if convenient, as there is considerable gassing and foaming. New acid must be added continually to keep the action up, and if there is much lime in the jacket it will help greatly to flush out the jacket with water, as a sludge will accumulate and prevent the acid getting to the surfaces in the lower part of the jacket.

There is no reason to fear corrosion; at least we have never seen any evidence of it. We have had the acid in engine jackets five or six hours at a time and on one occasion left it in over night. The fumes from the acid will cause rust on finished surfaces, so all polished surfaces should be coated with vaseline or cylinder oil before the pickling is started. Muriatic acid costs approximately 12c. per gallon, and a carboy will do a lot of pickling.

The company with which I am connected buys it by the carload, and we use it quite frequently in pickling engine jackets, pump-valve chambers, etc.

Anderson, Ind. G. O. BENEFIEL.

Public Utilities and Politics

The editorial in the Jan. 13 issue entitled "Public Utilities and Politics," is very much to the point. The statement, "The public will soon find means of combating those concerns that are organized solely to draw tribute from them over and above a fair return on their investment in the service" brings to mind a certain city that was served by a corporation that held the electric, gas and heat franchises.

The management of this property was quite unconcerned about the welfare of the city. The service was poor and very expensive, but those who were in a position to know, did not wonder at this for the plant was hopelessly out of date and in poor condition. With the exception of one Corliss engine every engine, boiler and pump has been purchased second-hand, patched up and made to run. The plant was poorly balanced and inefficiently operated, because they couldn't get a good engineer to stay long enough to get acquainted with the peculiarities of the plant.

On account of the poor service and excessive rates, manufacturers could not be induced to locate there, while the ones that were there complained bitterly. Finally the thing came to a climax. The city built an up-to-date plant of its own and not only reduced the rates, but paid off all interest and sinking-fund charges, retired all bonds as they came due, lighted all the important buildings and pumped the city water.

This does not necessarily mean that municipal ownership is more efficient than private ownership, but it does mean that the public expect reasonable service and efficiency from their public-service corporations and that there is a remedy if they don't get it.

Mankato, Minn. R. A. KAPLAN.

Repairing a Girth Seam of Return Tubular Boiler

In the Feb. 10 issue, C. R. Ragsdale asks for suggestions as to the methods of repairing the girth seam of his boiler. Before going further, I would say that the repair of this boiler appears to be up to builders rather than the engineer. They have not lived up to their contract, as their own representative has admitted, therefore before doing any welding or trying further schemes, Mr. Ragsdale should put the matter up to the builder and see what he has to say.

The trouble with this seam is probably just what Mr. Ragsdale says it is, but I have seen leaks like this happen from an altogether different cause. If this boiler is under pressure by being connected in a battery and the fire is allowed to go out without the main steam valves being closed, a leaky girth seam is likely to be the result.

Now about repairing the seam, I would like to make the following suggestion: Cut off and drive out every rivet that leaks. Make a strong solution of caustic soda and force it out between the plates, fill the boiler full of water if necessary to get pressure on the joint and let it leak and rust if it wants to. The probability is that there is more scale and dirt in the joint than drill chips and this method will clean it out. After washing out the joint, re-rivet and draw the plates together by the cold process; that is, keep the plates cold and use a hot rivet. Then when the rivet cools off they will pull the plates together with greater force. After riveting, calk the seam and it should stay tight.

This method has been used on a boiler in Massachusetts and was successful in overcoming the difficulty.

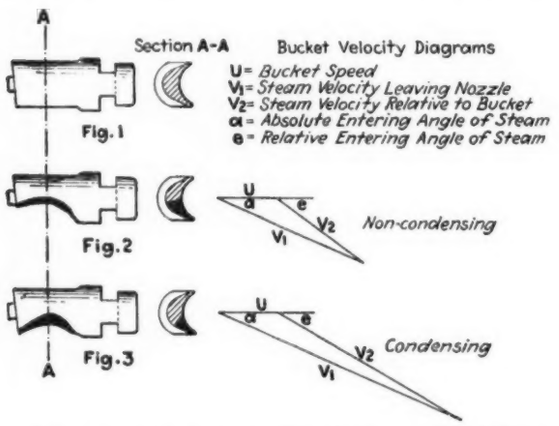
Personally, I do not think favorably of using an acetylene torch around a boiler. I do not claim to be an expert with the use of one, but I have seen so many deceptive welds that I am afraid of them. The Massachusetts State Police do not allow any acetylene welding done on boilers in this state as the result of tests made by them. I hope Mr. Ragsdale will be successful in overcoming his difficulty and that he will tell the readers of *Power* how he did it. BURTON W. WHEELER.

Rockland, Mass.

Erosion of Turbine Blading

I read with interest L. R. Wagner's article in the Dec. 30, 1924, issue, entitled "Dirty Feed Water Cuts Turbine Blades." The photographs of the worn buckets are especially interesting. The accompanying illustration shows how buckets wear under different conditions.

Foreign matter in steam due to dirty feed water has caused much erosion of the first-row turbine buckets in a large water-heating plant. In this plant the turbines consume a small percentage of the total steam generated, the main quantity being used in open heaters. For this reason it is considered impractical to make provisions for furnishing the turbines with clean steam. A new bucket is shown in Fig. 1 and eroded ones in Figs. 2 and 3.



How buckets wear under different conditions

The bucket shown in Fig. 2 was taken from a non-condensing turbine that had been operated at a steam pressure lower than that for which it was designed. This operating condition caused the spouting velocity of the steam from the nozzle V_1 and the velocity relative to the bucket V_2 to be decreased, thereby increasing the relative entering angle e until it exceeded the angle made by the back of the bucket. This tended to cause wear toward the back side of the blade.

The same turbine was rebucketed and run condensing, also at the lowered steam pressure. In Fig. 3 is shown a bucket taken from the turbine after having run two years under the changed conditions. The spouting velocity V_1 and the relative velocity V_2 were increased by condensing operation, causing a decrease in the relative entering angle e and the erosion to be more on the face of the bucket. Steel buckets are now being used instead of bronze, and the wear is inappreciable in comparison. C. L. ORR.

Gulf, Texas.

Welding Patches on Boilers a Dangerous Practice

As I have received considerable criticism of my article in the Nov. 18, 1924, issue, entitled "Welded Patches on Boilers a Dangerous Practice," I should like to state the reasons for my objection to welded patches on steam boilers.

One boilermaker said that I, not being a boilermaker, had very little to do to write such an article as that. I wish to state right here that the operating engineer should be more concerned about the safety of steam boilers than anyone else, for he is the one whose life is in danger when an explosion occurs. Of course I do not wish to intimate that a boilermaker would deliberately wish to have someone killed, but he, being in no danger, is naturally less interested in the safety of the boiler than in shortening the work as much as possible and doing it in the easiest way. Some of the important objections to welded patches on steam boilers are as follows:

When a hole is cut in the plates of a boiler and a patch fitted in, both the patch and the metal immediately surrounding the hole are heated to welding temperature. Both expand, the patch expanding outward, making it larger, and the metal around the hole, having no outlet except toward the hole, expands in that direction, thus causing the hole to become smaller. The metal in the seam, being in a molten state, allows this expansion to take place without interruption. When the welding is completed and the metal begins to cool, a reverse action takes place, which sets up a tremendous strain in the weld or seam. This is partly relieved by hammering as the weld cools, but not altogether. There is, no doubt, considerable tension in the seam when it is finished. Hammering is claimed to increase the efficiency of a welded joint about 10 per cent. The average efficiency of the welded joint (*Trans.* A.S.M.E., 1921) is about 71.4 per cent, in ½- and ¾-in. plates.

The longitudinal lap joint is no longer allowed by the A.S.M.E. Code in boilers or drums of more than 36 in. diameter and is prohibited altogether in some states. The reason for this is that a boiler of lap-seam construction does not form a true cylinder, but when pressure is applied, the pressure has a tendency to force it to a true cylindrical form. The shell bends in the weakest place (the joint) and as the pressure falls it partly regains its original shape. This action goes on until the metal becomes crystallized and finally cracks. There have been several boiler explosions from this cause in the last few years.

The same reasoning applies to the welded patch that is not in a true cylindrical form, which is nearly always the case on steam boilers. The weld being in tension, weaker than the surrounding surface and inherently harder, when subjected to this bending will crystallize and crack like the lap seam, only sooner.

I will admit there are many boilers with welded patches that have been in service for several years; there are also many boilers with lap-seam construction that have withstood the service of many years and may last many more, although they are considered dangerous by many good engineers.

To say the least, a longitudinal lap seam or a welded patch is a potential failure and the damage they may do can only be conjectured. H. T. SMITH.

Shamrock, Okla.

Questions and Answers

Conducted by

Franklin Van Winkle

Knocking of Pumps and Irregular Pressure in Circulating Lines

We have considerable annoyance from knocking in house water-service lines and irregular surging or spurting of drinking fountains which are supplied by triplex motor-driven pumps. The city water supply comes to the pumps at about 80 lb. pressure. The pumps are fitted with air chambers constructed from iron pipe a size larger than the discharge. Would the trouble be remedied by placing air chambers on the suction sides of the pumps? *J. G.*

Hammering at the pumps undoubtedly results from not keeping the present pump air chambers charged with air. When this is not done, an air chamber is a superfluous appendage. Wherever used, an air chamber should be supplied with a cock for draining off the water and an air cock for admission of air and, to determine the presence of air at sight while the pump is running, each air chamber should be provided with a glass water gage. Variable amounts of spurting at drinking fountains cannot be avoided unless the circulating lines are provided with liberal-sized air chambers for smoothing out irregularities of pressure due to having different numbers of fountains in use at the same time.

Reassembling Crosshead Shoes

If in reassembling a used engine which has bored guides, the crosshead shoes are not distinguishable, how may it be determined on which side of the crosshead each shoe is to be placed? *M. J. C.*

Engine builders usually provide marks for correctly assembling parts that are likely to become interchanged, but when no such markings can be discovered reassemble the parts according to the previous positions indicated by marks of wear, but in any case make proper adjustments for lining up the engine. On a horizontal engine that runs over—that is, when the top of the shaft turns away from the cylinder—the principal pressure of the crosshead against the guides is downward and the crosshead shoe that shows greater wear from the guide should be selected as the one previously used on the lower side of the crosshead; or conversely, if the engine runs under, place the shoe showing greater wear on the upper side. With a vertical engine the slide that receives greater wear from pressure of the crosshead will be on the opposite side of the cylinder center line from that side of the shaft which turns away from the crosshead when the shaft is turned in the running direction. When the shoes are in place, they should be adjusted to such positions with respect to the crosshead that there will be no tendency of the piston rod to move the stuffing-box gland or rod packing out of alignment, particularly when the piston is in the head end of the cylinder.

Relative Merits of Flush-Front and Overhung Return-Tubular Boilers

What are the relative advantages of the flush-end and the overhung-front types of return-tubular boilers? *A. R.*

The flush-end boiler has the flanging of both heads turned in and there is little or no danger of the rivets' becoming burned, the flush front presents a better appearance than the half-arch front with overhung uptake, and with the overhung end of the boiler less than about 5 ft. above the firing floor, it is in the way of the fireman. However, with the overhung type of setting the front wall of the setting needs to be only great enough to protect the half-arch front from the heat of the fire, whereas in the flush-end setting there must be sufficient thickness of front wall to cover the depth of the smoke connection and also form a good seal to prevent the hot furnace gases from escaping directly to the uptake in place of being first carried to the rear end and returned through the fire tubes. The overhung type of setting with thinner front wall has the advantages of requiring less depth of firedoor arch and dead plate to construct and maintain, the fireman has better access to the front corners of the fire, and the sealing of the fire from the uptake is unaffected by settling or shrinkage of the setting.

Fuel Saving from Returning Condensate of Exhaust Heating System

What percentage of fuel would be saved in a mill that is equipped with an exhaust-steam heating system if the temperature of condensate discharged from the heating apparatus is 200 deg. F.? The temperature of the boiler-feed water at present obtained from the exhaust-steam feed-water heater is 180 deg. F., and the boilers are operated at the pressure of 125 lb. gage. The condensate from heating apparatus is equal to about one-third the total boiler-feed water required when the engine is operated, but contains oil carried over in the exhaust, and we would have to go to considerable trouble and expense to make the water harmless to the boilers. *A. A. S.*

It is fair to assume that there would be a drop of at least 5 deg. F. in the temperature of the condensate to render it suitable and discharge it to the heater, and that the resulting feed-water temperature would be approximately $\frac{1}{3}$ (200 — 5) + $\frac{2}{3}$ (180) = 185 deg. F. As about 10 deg. F. increase in temperature of feed water is required for a fuel saving of 1 per cent, under the stated conditions utilization of the return water by discharge to the feed-water heater should result in a fuel saving of about one-half of one per cent. This, however, is applicable only to fuel consumption during the period when the heating apparatus is supplied with exhaust. In most cases where exhaust steam is used

for warming buildings, the amount of heat obtained from the exhaust during the heating seasons is about the same as that which is obtained from live steam while the exhaust is not available.

Assuming that during live-steam heating the average temperature of feed water is 45 deg. F., then, without allowance for other uses of steam, utilization of the return water at the temperature of 195 deg. F. in place of raw water at 45 deg. F. would result in a saving of about (195 — 45) ÷ 10 = 15 per cent of fuel chargeable to the generation of steam supplied to the heating system. Since the total amount of condensate from the heating system is one-third of the total required during exhaust-steam heating, the average daily amount of feed water required for live-steam heating would be about the same amount. Hence during the heating season, while heating by exhaust there would be three-fourths of the average daily fuel consumption and one-fourth during live-steam heating. Consequently, the average daily saving from returning feed water during exhaust heating would be only ¾ of ⅓ of 1 per cent, but the saving from return of feed water during live steam heating would amount to about ¼ of 15, or 3¾ per cent of the average daily fuel consumption during the heating season.

Repairing Bag in Boiler Shell

How is repair made to a bulged or bagged fire plate of a boiler? *M. C.*

A considerable amount of bagging may be repaired by boring a hole about one-half inch in diameter through the plate at the point of deepest bulging, then heating the plate and pounding it back to proper form and alignment. The pounding, bucked up on the inside of the boiler, should be begun evenly all around the outside of the bag, gradually approaching the drilled hole which becomes partly closed. When reshaping of the plate has been completed, clean out the hole by drilling, countersink from both sides to remove burrs, fill the hole with a hot rivet and, if convenient, seal around the edges of both rivet heads by electric or oxyacetylene welding.

If the bagging is accompanied by burning or material reduction in thickness of the boiler plate, the bulged portion should be cut away and repairs made with a hot-riveted patch, of the same thickness as the boiler shell, placed inside of the boiler and held with size and arrangement of rivets which will allow of the same safe working pressure as the longitudinal seams of the boiler shell.

Setting Valves of Two-Cylinder Engine with Reversing Throttle

How would the valves be set on a reversible two-cylinder engine having cranks at right angles, and how is reversal effected? Each cylinder is provided with a slide valve and fixed eccentric, and there is a reversing throttle valve between the cylinders. *L. M. W.*

The office of the reversing valve is to interchange the steam supply with the exhaust so that the engine is reversed from changing the steam admission to the opposite side of the pistons. The diagram illustrates the arrangement of a reversing valve *V* in the form of a *D* slide valve for controlling one cylinder provided with a slide valve *D* of the ordinary form. Pipes *X* and *Y* are connected with ports *x* and *y* of the steam chest that contains the reversing valve *V*. Between these ports is an exhaust passage *P* which is connected to the main exhaust pipe, and live steam from the boiler is admitted to this steam chest at *L*. Ports *x* and *y* are shown covered by the valve *V*. When *V* is moved downward, the port *y* opens, and connection of the central passage *E* is made through *Y* with the exhaust outlet *P;* and at the same time the port *x* is opened for connection of the main steam chest *S* through *X* with the steam chest of the reversing valve *V*. The engine then operates as an ordinary slide-valve engine with *D* slide valve having outside admission. But when the valve *V* is raised the engine is reversed as *E*, through the connection *Y* and port *y*, is placed in communication with the live steam supply *L*, while *S*, through the connection *X* and port *x*, is placed in communication with the exhaust connection *P*.

In place of a *D* form of slide valve, different types of balanced valves are used for interchanging the steam and exhaust under the general designation of reversing throttle valves.

For a two-cylinder reversing engine in which each steam chest *S* is in communication with the same con-

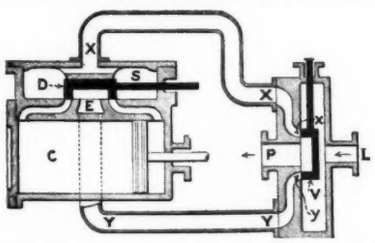


Diagram illustrating connections of reversing throttle

necting pipe, *X* or *Y*, set the main valve of each side as a separate engine with reference to the direction of rotation that is to be obtained by admission of steam at the ends of the main valve. Remove the steam-chest cover and, with the eccentric firmly set on the shaft, turn the engine over and obtain the same travel of each outside edge of the valve beyond the outside edge of its port by adjusting the length of the valve rod or eccentric rod. Next make a mark on the crosshead and locate a corresponding mark on one of the guides when the crank is on first one dead center and then the other and set the eccentric on the shaft so one outside edge of the valve gives the same amount of port opening as the other in the beginning of a stroke when the engine is turned through a complete revolution and in the direction it should turn for admission of live steam to the steam chest *S*.

In the same manner equalize the valve travel of the other cylinder by adjusting the length of its valve rod, and set the eccentric to obtain the same amount of outside valve opening at the beginning of the stroke, when the engine is turned over in the same direction as the direction that was assumed to be proper for admission of steam to the steam chest *S* of the other cylinder, *provided* both steam chests are connected with the same steam port *x* or *y*. If the steam chest of the second cylinder is connected with a different steam port of the reversing valve, the direction of motion assumed for setting the eccentric for the second cylinder must be the reverse of the direction that was assumed in valve setting of the first cylinder.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Why Flywheels Burst

THIS is not an article on flywheel design, but merely an attempt to explain in a simple manner how, and to what extent, rotation produces a tension in the rim of a flywheel. For simplicity it will be assumed that the rim is jointless and that the spokes do not assist the rim in resisting the centrifugal forces. In practice these factors must be considered, but the simplified case should be understood first.

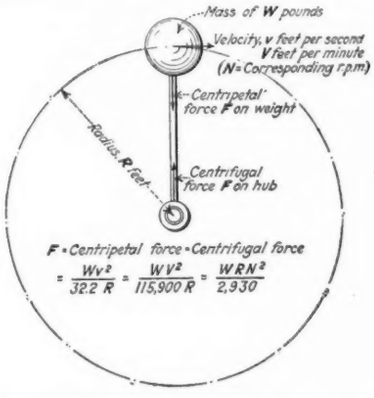

Mass of W pounds
Velocity, v feet per second
V feet per minute
(N = Corresponding r.p.m)
Centripetal force F on weight
Radius, R feet
Centrifugal force F on hub
F = Centripetal force = Centrifugal force
= Wv²/32.2 R = WV²/115,900 R = WRN²/2,930

Fig. 1—Formulas for centrifugal force with meaning explained

Fig. 1 illustrates the formulas for figuring centrifugal force. Any of the three forms shown may be used. Table I was computed from the last formula given. It will be noted that the force increases as the square of the r.p.m. Doubling the revolutions gives four times the force, tripling gives nine times the force, etc. For weights and distances other than one pound and one foot, multiply the table values by the actual weight and radius (in feet) of rotation.

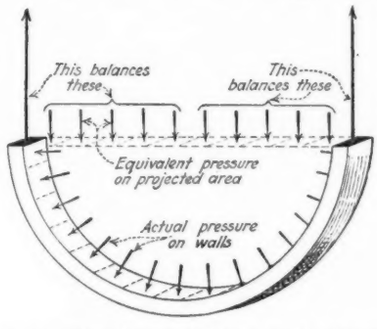


Fig. 2—Tension in boiler shell balances pressure on half projected area

Centrifugal force produces a pure tension in the rim. As may be seen by comparing Figs. 2 and 3 the effect is closely analogous to the tension produced in the shell of a tank by the internal pressure. Taking a section of the tank as shown in Fig. 2, the total tension on one side is equal to the pressure on half of the projected area of the tank cross-section.

TABLE I—CENTRIFUGAL FORCE OF ONE POUND WEIGHT WITH CENTER OF GRAVITY AT ONE FOOT RADIUS

Revolutions per Minute (N)	Centrifugal Force, Pounds (F)
200	13.6
400	54.7
600	123
800	219
1,000	341
2,000	1,360
4,000	5,470
8,000	21,900
12,000	49,100

In the same way (Fig. 3) the centrifugal force per square inch along the circumference of a flywheel is equivalent to the same force per square inch acting along the projected area, and the tension in one side must equal the equivalent force or pressure along one half of the projected area.

The safe speed for flywheels is often stated in terms of rim speed without reference to the diameter of the wheel or the shape or area of the rim cross-section. The logic of this is shown by Figs. 4 and 5, assuming that the material has the same strength and weight per cubic inch in all cases. Fig. 4 compares two wheels having the same diameter and rim speed, but different cross-sectional areas. If the velocity is such that the tension in the thin rim is 1,000 lb., that in the heavier rim, which weighs eight times as much, must be 8,000 lb. But the larger wheel has 8 sq.in. of metal to carry the tension, so the stress is 1,000 lb. per square inch in both cases.

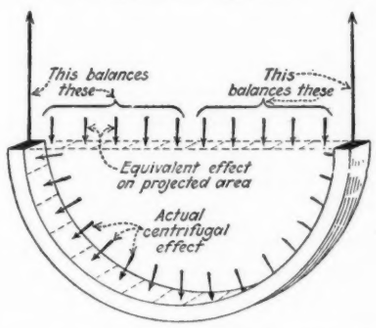


Fig. 3—Tension in flywheel rim balances centrifugal "pressure" on half projected area

TABLE II—UNIT TENSION IN RIM FOR VARIOUS RIM SPEEDS

Rim Speed, Ft. per Min.	—Tension in Rim, Lb. per Sq.In.— Wrought Iron	Steel	Wood
2,000	115	118	9
4,000	460	470	36
6,000	1,040	1,060	81
8,000	1,840	1,880	144
10,000	2,880	2,940	225
12,000	4,150	4,240	324
14,000	5,650	5,760	441
16,000	7,370	7,540	576
18,000	9,350	9,540	730
20,000	11,500	11,800	900
25,000	18,000	18,400	1,410
30,000	25,900	26,400	2,020

Fig. 5 compares two wheels of the same cross-section, material and rim speed, but of different diameters. According to the second formula of Fig. 1 the centrifugal force of each pound of metal will be greater in the small wheel, it being inversely proportional to the diameter. The larger wheel, however, has just enough more weight of metal (or cross-sectional area, if the problem is considered in the light of Fig. 3) to make up for the smaller centrifugal force of each pound.

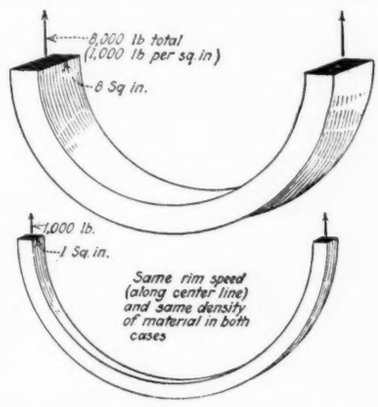

8,000 lb total
(1,000 lb per sq.in.)
8 Sq in.
1,000 lb.
1 Sq.in.
Same rim speed (along center line) and same density of material in both cases

Fig. 4—Tension per square inch is independent of rim cross-section

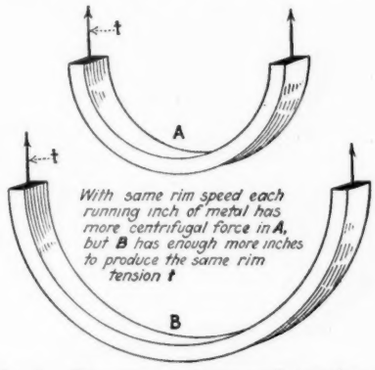

t
A
t
With same rim speed each running inch of metal has more centrifugal force in A, but B has enough more inches to produce the same rim tension t
B

Fig. 5—For same rim speed tension is independent of diameter

Two things only determine the rim tension per square inch. One is the linear velocity (measured at the center of the rim section) and the other is the weight of the material per cubic inch. Table II gives the tensile unit stress for various materials and rim speeds, based on average materials.

Some Recent Developments in the Use of High Pressure and Superheated Steam*

By B. N. BROIDO
Chief Engineer, Industrial Division, The Superheater Company

THE opinion has been frequently expressed that the greatest difficulty in the application of very high steam pressures would be the construction of suitable boilers. Little concern has been voiced as to the use of high-pressure steam in reciprocating engines, but doubt has been expressed as to the possibility of utilizing the extended range in heat in turbines due to the greatly increased losses in the blades. Turbine losses become greater as the pressure of the steam is increased, because losses in the turbine blades, due to friction and leakage, increase as the density of the driving medium increases. Fortunately, great progress has been made in eliminating the difficulties encountered in the design of high-pressure boilers and turbines.

A careful study and analysis of boiler performance, particularly with respect to the heat absorption and water circulation, has thrown more light on difficulties expected with high-pressure boilers and also has shown how to eliminate these difficulties.

Investigations regarding the properties of boiler materials, the influence of the manufacturing process on the strength of the material, the progress in the production of special steel plates and their treatment for the manufacture of boilers, all were important factors in the design of high-pressure boilers. The latest developments in superheaters were along the lines which made them adaptable to high pressures and temperatures. The designs of valves and fittings have also so far advanced that they can be made suitable for enduring severe conditions in connection with high pressures.

The remarkable tendency toward higher pressures, which is clearly manifested today, will compel manufacturers to find suitable kinds of boiler materials. The capacity of machines and qualities of materials from which they are to be made are at present the most important questions in modern engineering. While it will probably be some time before these questions will be definitely solved, considerable progress has already been made.

Recent Developments in Superheaters

Up to recent years, superheaters in water-tube boilers were located almost exclusively above the main bank of tubes or between the first and second gas paths. In this location the temperature of the gases was sufficient for comparatively low superheat. The superheat obtained in this location varied with the rating of the boiler. At higher ratings the superheat was higher due to the increased amount of gases at a higher temperature, also the greater velocity of the steam. At low ratings the superheat will drop. For low average superheat, these temperature fluctuations are of little consequence, as in any case the final temperatures are not excessive.

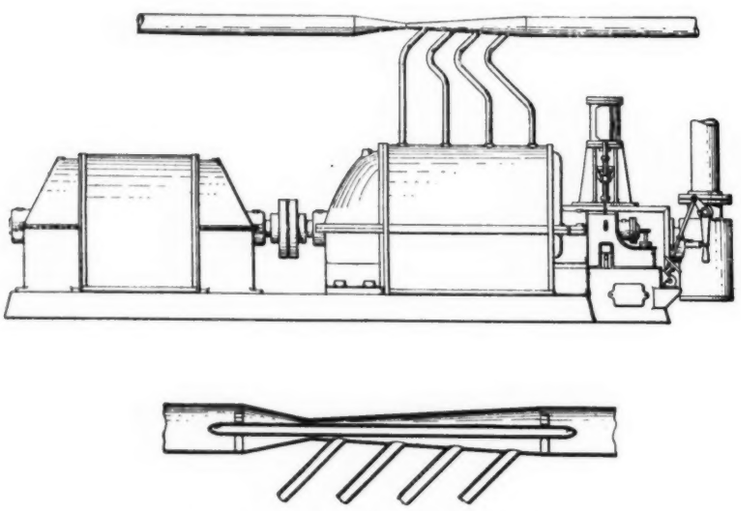


Fig. 1—Venturi stage feed heater

With increased pressure and superheat constant temperatures are imperative, as any temperature fluctuations cause additional stresses in the prime mover which may become detrimental. In Europe special temperature regulators were designed and were often applied with superheaters for high temperatures. American engineers have approached the problem from another viewpoint. Proceeding from the fact that any load variation applies to both boiler and superheater, as the exact amount of steam generated by the boiler must pass to the superheater, the superheat will be constant if the heat absorbed by both boiler and superheater varies in the same proportion.

On the other hand it is a known fact that the first few rows of boiler tubes generate most of the steam, so that a superheater located between or near these tubes will be subjected to the same variation as the part of the boiler where most of the steam is generated, and in this way will approach closely the ideal conditions for constant temperature. This arrangement was first applied in the large boilers at the River Rouge plant of the Ford Motor Co. The remarkable results obtained with this installation have caused the designer of the superheater to apply the same principle in other types of boilers.

Since then, a number of installations with superheaters in this location were put in operation, every one of which has borne out this theory. Thus it seems that the acme in superheater design for high pressures and temperatures is attained. It has been questioned whether superheaters located in high gas temperature zones are safe for high pressure. It should, however, be borne in mind that the higher the steam pressure and the denser the steam, the more cooling effect it has on the metal walls of the superheater tubes.

High Steam Velocity Desirable

With the rapid increase in pressures and superheat, the question of steam velocity in the superheater elements attained more importance. High steam velocity keeps the inside of the element clean, preventing accumulation of scale, which is the more objectionable the higher the pressure of the steam, as the metal temperature of a superheater unit in contact with the hot gases is established somewhere between the gas and the steam temperature. The higher the velocity of the steam and the cleaner the pipes inside the nearer is the metal temperature to that of the steam.

Owing to the fact that the surfaces of a superheater are exposed to high-temperature gases and depend for their cooling upon the flow of steam, internal stresses are occasioned in the superheater structure. This is aggravated by the fact that steam becomes a less ready absorbent of heat as it becomes superheated. No matter how properly a superheater may be designed, its service is always more

*Excerpts from a paper presented at joint meeting of the Engineering Society of Western Pennsylvania and the Pittsburgh Section, American Society of Mechanical Engineers, Oct. 6, 1924.

severe and more likely to cause disturbances in operation than is the case with boiler design.

This applies to any superheater, but particularly to those for modern boilers designed for high pressure and high temperature. An up-to-date superheater, adaptable to the present and near-future requirements as to pressures and temperatures, must be so located that it is easily accessible so that it can be adjusted or inspected and boiler operation resumed in a minimum of time and cost.

High Pressure in Engines and Turbines

It is a well-known fact that in any double- or multiple-cylinder reciprocating engine the high-pressure cylinders are the most efficient, so that when high-pressure steam is used, the higher the pressure the higher is the efficiency of the first cylinders. The first tests made with high-pressure steam were with reciprocating engines, and remarkable results were obtained. In a four-cylinder engine of 150 hp. the steam being resuperheated before entering the low-pressure cylinder and expanding to 3 lb. absolute, an indicated horsepower was obtained with 8,220 B.t.u. The steam consumption was 5.22 lb. per horsepower-hour, the initial steam being at a pressure of 800 lb. and temperature of 815 deg. F. and the vacuum 28½ in. The steam was resuperheated above the second cylinder to 600 deg. F. and above the last low-pressure cylinder to 400 deg. Taking into consideration the live steam required for resuperheating, an indicated horsepower was obtained on 5 lb. of steam. These results are probably the best that were ever obtained with a reciprocating engine, and can hardly be improved upon.

Different types of cutoff-valves have been tested in connection with high-pressure steam, including slide, piston and poppet valves. It seems that the piston valve is best suited for very high-pressure and temperature steam.

Particularly in cases where the engine exhausts against a back pressure, the conditions are very favorable to high pressure, a comparatively small cylinder being required for even large capacities.

With steam turbines the conditions are reversed from that of reciprocating engines, the efficiency of the high-pressure stages of the present turbines being considerably lower than that of the low-pressure stages. Engineers were, therefore, somewhat in doubt regarding the benefit of high-pressure steam in turbines, but certain recent designs have largely overcome these difficulties.

Methods of Bleeder Heating

There were, until recently, two ways of accomplishing the regenerative cycle. The first is to have the water raised to the boiler pressure by a pump. It passes then to as many closed feed-water heaters as there are stages bled, while its temperature increases nearly to that of the steam bled.

The second method of regenerating is to have the water flow to open feed-water heaters where it comes in direct contact with the steam. In this case the pressure of the water cannot be higher than that of the steam, so that a separate pump is required between each two stages in order to raise the water to the pressure of the next higher stage. One of the drawbacks of both of the foregoing arrangements is their complication.

A new arrangement was recently suggested which seems to have overcome the difficulties. It is illustrated in Figs. 1 and 2. With this arrangement neither multiple pumps nor multiple heaters are required. The water to be heated is raised to a pressure enough higher than the boiler pressure to take care of friction losses through the device. This may be done by a standard feed-water pump. As shown in the figures, the feed line is gradually reduced in cross-sectional area to a small size and then gradually increased again to the original size of the pipe, similar to the reduction and increase of area in a venturi meter.

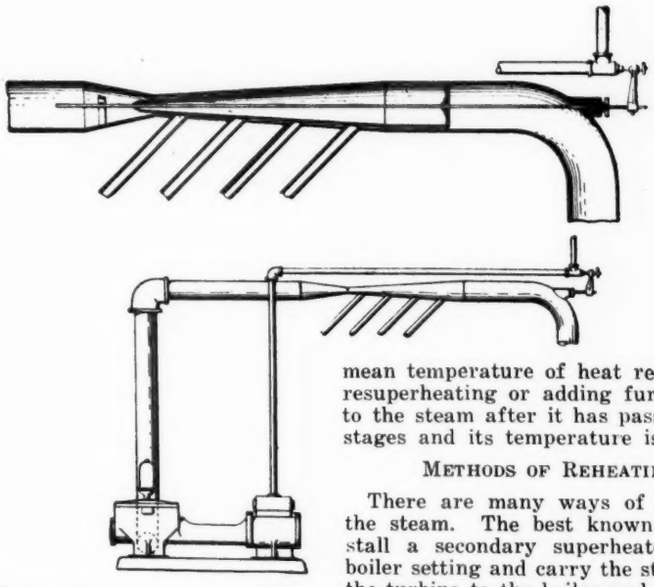


Fig. 2—Enlarged view of venturi heater

The section must be sufficiently reduced so that the pressure is less than the steam pressure of the lowest stage of the turbine from which steam is to be bled. The steam from this stage is introduced at this point and heats the feed water to the temperature corresponding to the pressure. At a point farther along the gradually increasing section where the pressure, although higher than at the first point, is lower than the steam pressure of the next higher stage of the turbine from which steam is to be bled, this steam is introduced raising the temperature of the water to that corresponding to the steam pressure. Steam from as many stages of the turbine as desired is thus introduced at points along the increase in area, in each case the water pressure being less than the steam pressure, so that the steam from the turbine can enter and mix with the water. After the last point of introduction of steam, the area of the cross-section is still further increased so that the velocity head is transformed back to pressure head sufficient for the water to enter the boiler.

With this arrangement it is possible to heat the water by bleeding from many stages without undue complication, as all that is necessary for each stage is a pipe connection provided with a check valve between the heater and the turbine, so that all advantages in connection with multiple-stage heating can be obtained in a comparatively simple manner. It may be worth while mentioning that this new development is now made public for the first time.

A second method of increasing the mean temperature of heat reception is resuperheating or adding further heat to the steam after it has passed a few stages and its temperature is reduced.

Methods of Reheating

There are many ways of reheating the steam. The best known is to install a secondary superheater in the boiler setting and carry the steam from the turbine to the boiler and then back to the turbine again. This arrangement, however, has many disadvantages, as the pressure of the steam for reheating is considerably lower than that of the live steam. The pipes carrying the steam to the boiler and back must be, therefore, of a large size, which complicates the installation. While there are now on the market superheaters that give fairly constant temperature at different ratings, some fluctuations may occur, due to varying conditions in the furnace. The temperature drop of the steam in the turbine will, of course, vary, depending on the load etc. If the steam is sent back to the superheater installed in the boiler setting, we have a third variation, so that the total fluctuation of temperature of the reheated steam may become very serious.

A much simpler arrangement is to reheat the steam in a separately fired superheater. It is generally believed that separately fired superheaters are inefficient. There are on the market however, separately fired superheaters that have water tubes in the furnace ahead of the superheater, and that can be operated with high furnace-gas temperatures and are very efficient, particularly when taking into consideration that the steam to be heated is of comparatively low temperature and that correspondingly, the exit gas temperature is also low.

This would work out satisfactorily in a plant where the auxiliaries are driven electrically from the main switchboard and there is no exhaust

steam available for heating the water. The feed water would then be heated in the water surface of the separately fired superheater. This arrangement would give a high over-all efficiency, and it would be less complicated, as the separately fired superheater could be located in the turbine room and fired with either oil, gas or coal. In the case of coal it would be located in the turbine room between the boiler and turbine, with the furnace operated from the boiler room.

A still more convenient method of reheating steam is by having live steam from the boiler supply the necessary heat. This is particularly advantageous for highest pressure. Naturally, the steam cannot be reheated to the initial temperature of the live steam, but this method has many advantages which make it more desirable than others. It is not necessary to carry the steam back to the boiler room, as the reheater can be located near the turbine. The apparatus for reheating requires a comparatively small amount of heating surface, as the heat absorbed is the latent heat from the steam, which is easily given up, and the heat transmission coefficient is very high.

The most important advantage is the possibility of regulation. As already mentioned, the regulation is of considerable importance in connection with reheating of the steam. If reheating is accomplished with live steam, the regulation is much facilitated, as all that is necessary is to regulate one valve admitting the live steam to the heater. This is an important factor in favor of reheating by live steam. Fig. 3 shows a live-steam reheater with a capacity of 200,000 lb. of low-pressure steam per hour.

In order to reheat the steam to a higher temperature than that of live saturated steam, it was suggested that two reheaters in series be used. The first increases the temperature of the exhaust steam to the saturation temperature of the live steam while in the second reheater superheated live steam is used to increase further the temperature of the exhaust steam.

A rather original method of reheating steam is to install a separate high-pressure boiler in the boiler room, the steam from which is used only for reheating. In this case, except for the additional boiler which must operate at a considerably higher pressure than the main boiler, this arrangement has all the advantages mentioned.

High Pressures Offer Larger Gains with High Back Pressures

The most startling characteristic of high-pressure steam is the advantage obtained by its use in prime movers exhausting against a back pressure. By back pressure I mean any exhaust pressure higher than that of the atmosphere. From the present back-pressure engines with the usual comparatively low initial pressure, we can expect only a dilatory development, for the reason that with the increasing back pressure the greater part of the heat in the steam available for work is withdrawn. If the initial steam is of a considerably higher pressure, however, the heat withdrawn with exhaust steam is of less consequence.

The Allegheny Steam Heating Co. is building a plant with two 30,000-sq.ft. boilers. If they were to build these boilers to operate at 800 lb. pressure with 200 deg. superheat and used the steam in a turbine expanding to a high back pressure, considerable power would be obtained without a material increase in the amount of coal burned. Say they operated the boilers at 200 per cent rating and exhausted the steam from the turbines at 100 lb. back pressure into their heating lines, the amount of power generated would be about 22,000-hp., while the additional amount of coal burned would hardly be noticeable.

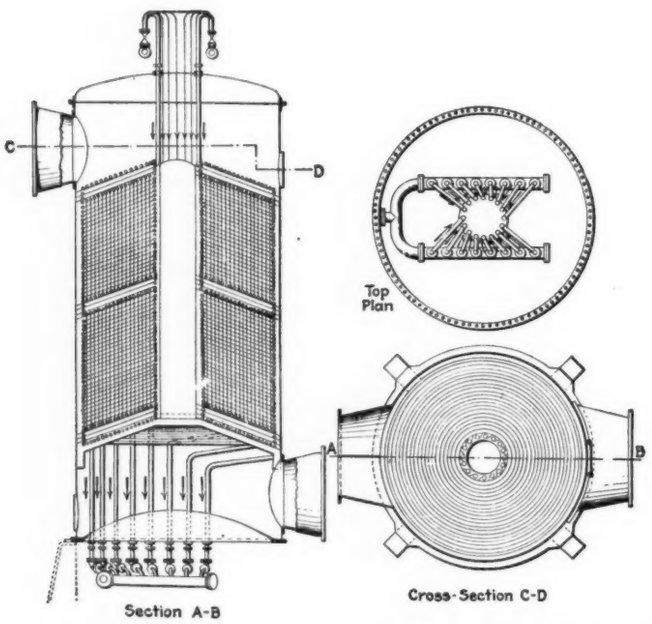


Fig. 3—Reheater by live steam with 200,000 lb. per hour capacity

Operating Corliss Engines*

Starting

1. Notify switchboard operator that machine is ready to be warmed up.
2. After receiving affirmative reply, see that all drains from the cylinder are open.
3. See that the drain and trap above the throttle valve are open.
4. See that the main exhaust valve is open.
5. If a compound engine, see that the receiver is drained.
6. See that the wristplate is unlatched from the eccentric rod hook.
7. See that oil is running to the bearings of the engine.
8. See that the crank and crosshead pit drains are open and free.
9. See that the cranks, crossheads and other movable parts are not obstructed by any foreign material.
10. See that the wristpins, crankpins, eccentric straps and wristplate pins are tight.
11. See that the valve-gear nuts, etc., are tight.
12. See that the crank is in such a position that the engine will start readily.
13. See that the governor belt, when used, is in good condition and free from oil.
14. Examine all gages.
15. Oil the governor spindle and see that the dashpot has the necessary amount of oil.
16. Start the circulating, air and hotwell pumps, and get partial vacuum in the condenser.

Note: Regulate hotwell pump so that proper water level is maintained above pump suction.

17. See that the governor is hooked up on the safety pin.
18. Place the bar in the wristplate of the engine.
19. Open the bypass valve, or crack the throttle, admitting steam alternately to each end of the cylinder, warming it up and getting all the water out of the valve chest and cylinder.

Note: Shifting of valve gear to permit steam to enter alternate ends of cylinder shall be done with throttle or bypass valve closed, owing to the wear and tear on the crankpins and boxes when this operation is performed under steam pressure.

20. Open the throttle valve farther until the engine revolves slowly, then engage the wristplate with the eccentric-rod hook.
21. See that the lubricator and oiling system are in operation.
22. Notify the switchboard operator that the machine is ready for operating speed.
23. After receiving affirmative reply, open the throttle slowly and close the bypass valve, noting that the engine comes up to proper speed.
24. See that the safety pin of the governor is in a correct position to operate, should the governor belt break.
25. Close the drains.
26. Signal "Load" to the switchboard operator.

*Instructions from recent operating code of the N. E. L. A.

27. As the load comes on, bring the vacuum up to normal.

Shutting Down.

1. After receiving the signal "Stand By" from the switchboard operator, answer it.
2. After receiving and answering the signal "Stop" from the switchboard operator, close the throttle slowly until the engine comes almost, but not quite, to a stop.
3. Reverse the safety pin of the governor so that the governor will not drop to the lowest point.
4. Place the bar in the wristplate.
5. Disconnect the wristplate from the eccentric rod.
6. Operate the wristplate by hand with the bar so that the engine will stop with the crank in starting position.
7. Move the wristplate to a central position so that the exhaust valves are closed.
8. If the engine has a double eccentric, trip the steam valves by hand when the wristplate is in a central position so that the steam valves may be closed and lapped.

Note: A test should be made periodically by leaving the governor safety pin in the running position when shutting the throttle valve, to see that the safety device is in working order.

9. Shut down the circulating, air and hotwell pumps.

Note: If jet condenser is used close off injection water just before closing throttle valve and allow air or wet vacuum pump to run until engine stops, thus obviating, to some extent, the possibility of water being forced by atmospheric pressure through air or wet vacuum pump into the low-pressure cylinder in the event of displaced or defective valves in the pump.

10. Shut off the oiling system.
11. Open the drains.

Designing Turbines for Maximum Steam Pressures

SINCE the frictional losses due to rotating disks and vanes in impulse turbines vary directly as the density of steam, turbines for extremely high pressures would be subject to these in excess for the high-pressure stages unless steps were taken to decrease such frictional losses by some means.

The fundamental equation for disk friction loss shows that this is equal to the product of a constant and three quantities raised to suitable powers. In other words the disk friction loss in any stage equals a constant multiplied by the square of the diameter, and the cube of the blade velocity, and by the density of steam such as the weight in pounds per cubic foot.

Where L is the loss, D the disk diameter, S the peripheral speed, R the rotative speed, H the average internal steam density, such as pounds per cubic foot, and K_1 a constant the relations would then be

$$L = K_1 D^2 S^3 H;$$
$$L = K_1 D^2 (\pi DR)^3 H = K_2 D^5 R^3 H$$

If the speed is already fixed, such as would be the case with a 60-cycle generator, where 3,600 r.p.m. is the maximum, it is obvious that by reducing the diameter, these losses would be lessened about as the fifth power of the diameter. This, however, also reduces the blade speed, which depends on disk diameter, and as a result the number of stages would necessarily be increased.

The energy that each stage extracts per pound of steam depends on the square of the blade speed. Therefore, if the diameters are cut in half it would be necessary to use four times the number of stages in order to extract an equal amount of energy approximately from a pound of steam over the same expansion pressure range.

As lowering the disk diameters and increasing the number of stages would be an expensive method of meeting these conditions, an alternative of raising the rotative speed of the turbine at the same time that the rotor diameter is reduced, might be preferred.

Suppose, for instance, that a standard economical 3,600-r.p.m. turbine for 200-lb. steam is to be redesigned for much higher pressure, such as 2,000 lb., but still to have the same blade speed and with practically the same amount of disk friction loss as in the case of the former pressure. The fundamental formula can then be used to show that speeds of the two turbines should be proportional to the square roots of the average internal steam densities.

Since S and L in the aforementioned formulas are now both constants, it appears that for either turbine,

$$D = K_3 \sqrt{\frac{1}{H}}$$

$$\text{Since } S = \pi DR, \text{ and } D = \frac{K_4}{R}, \text{ then}$$

$$R = K_5 \sqrt{H}.$$

The speeds of the two turbines under discussion, R_1 and R_2, are then proportional in the relation,

$$R_1 : R_2 = \sqrt{H_1} : \sqrt{H_2} \text{ and } R_2 = R_1 \sqrt{\frac{H_2}{H_1}}$$

On two turbines of this kind, as pointed out by V. Nordstrom[1] at the World's Power Conference, the average densities of steam the high-pressure stages vary in about the same ratio as the initial steam pressures before expansion. Considering the initial absolute pressures as P_1 and P_2, then

$$R_2 = R_1 \sqrt{\frac{P_2}{P_1}}; \quad R_2 = 3{,}600 \sqrt{\frac{2{,}000}{200}}$$

= 11,500 r.p.m. approximately.

The general conclusion therefore would be that a turbine for greatly increased pressure, such as 2,000 lb., should run at 11,500 r.p.m. and therefore require gearing to a generator. The loss through gearing is ordinarily in the neighborhood of 2 per cent, which for extreme pressure increases may be cheaper than utilizing the same rotative speed at an excessive number of turbine stages.

Several other related points were touched upon by Mr. Nordstrom. Owing to the greater expansive energy theoretically available with the higher initial pressure, either the number of disks or the peripheral speed must be increased. From this it follows that, in order to keep the friction losses down, the rotative speed of the turbine must be still further increased, and as there is no possibility of directly utilizing the power produced at such a high speed, the solution of gearing suggested by Gustaf de Laval in the early nineties must be adopted.

Full Pressure on Few Nozzles Preferred to Throttling

Concerning partial admission, it might appear as if the arrangement would be superfluous in the present case, since the importance of this system for the economy of the machine diminishes when the range between admission and discharge pressure is increased. A closer investigation of the problem shows, however, that about the same gain is possible as at a lower admission pressure. If the gain is expressed in units of power (and not in per cent) this applies to condensing turbines as well as to back-pressure turbines.

Thus the same reasons for fitting turbines designed for ordinary pressures with partial admission, hold good also in the case of extra-high-pressure turbines. It may be said, as a general rule, that the question for or against partial admission depends upon how great the variation in steam consumption is expected to be.

The very high steam pressures may in the first instance find employment in back-pressure turbines, where the economy of this arrangement is obvious. The gain in energy expressed in per cent is so considerable that the figures are likely to be quite astounding. However, the gain ought not to be estimated in this way, which would be misleading, but should be based on the actual fuel saving.

Superheat Easily Obtained

Looking at the matter in this light, it will be found that the gain under certain circumstances can be quite as large for a complete condensing plant as for an extraction turbine, or for a combination of a back-pressure and condensing turbine. The deciding point here is how high a superheat can be employed at the higher steam pressure.

It is indeed probable that higher temperatures than the ones heretofore regarded as most suitable at standard steam pressure may be used, because the greater heat capacity of the high-pressure steam will reduce the difference in temperature between the superheater coils and the steam. Only experience can show, however, how far the superheating can be carried in excess of present practice.

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[1]Chief Engineer, de Laval Angturbins Co., Stockholm.

Requirements of Auxiliaries To Furnish Reliable Service*

By G. G. BELL
Manager Power Development, West Penn Power Co.

IN MOST of the large generating stations it has been the practice to install alternating-current motors for driving all but a few of the smaller power-station auxiliaries which require the greatest range of speed and fine adjustment. One of the latest stations to be built has decided to install steam-driven auxiliaries throughout and claims expected efficiencies comparable with those obtained in heating the feed water by bleeding the main unit and operating motor-driven pumps.

Experience at the Springdale station with motor-driven auxiliaries has been so much more satisfactory than with turbine drives, that the installation of motors would be considered even at some sacrifice in efficiency, owing to the following reasons: The operators prefer to work with motors and the trouble of maintaining them is less; the higher steam pressures require constant maintenance of valves and glands to keep them tight; the percentage of makeup required is invariably higher in a plant equipped with steam-driven auxiliaries, and where evaporated water is used, the investment in evaporators is increased and the heat balance of the plant affected.

Steam-driven auxiliaries require a large amount of piping, which usually interferes with the facility with which repairs can be made to the unit. In general, steam turbines run at a much higher speed and frequently require gearing, so that both of these things tend to increase maintenance. More powerful governors are required for the higher pressures and temperatures used today. If saturated steam is used, the heavy cutting of the nozzles and the turbine blades will require renewal after a few years' operation. Finally, the ventilation in the modern power house is much better than in former times, so that working temperatures are suitable for motors for all uses.

Exciters

With reference to the requirements of the different auxiliaries, some interruptions in the services rendered by all of them, with the exception of the exciter, is permissible so that for the exciter the most reliable type of drive is essential. The majority of plants equip main units with direct-connected exciters and provide relay excitation from motor-generator sets or duplex-driven units. The majority of plants not having direct-connected exciters have duplex-driven units, and experience indicates that either type of equipment gives reliable service. In some cases automatic throwover has been provided and has worked satisfactorily.

Paralleling of steam-turbine-driven and motor-driven generator sets has caused trouble, as a result of motoring of the steam-driven set. Apparently, the reliability of such sets is increased if they are provided with an alternating-current motor for driving, which will act as a brake in case there is any tendency for the set to be motorized and to over speed.

Circulating Pumps

With circulating pumps a short interruption is permissible, but if the interruption is long enough for the condenser to become vapor-bound, the length of time required to get the unit back into service is likely to be longer than if there is a failure of the excitation. For this reason it is essential that at all times some water be kept going through the condenser, so that in most stations equipped with electrically driven auxiliaries, duplicate pumps and duplicate sources of power are provided, and in some cases one circulating pump has a duplex drive as well. Where duplex drives are not provided, the pumps generally are both driven from the most reliable source of power, or at least one pump is operated from it.

In case of the failure of either source of supply, the writer's experience has been that check valves in the pump were not necessary. If one pump only is running, there will be an increased flow of water from it on account of the reduction in the friction head owing to the smaller quantity of water circulated through the condenser. If one pump accidentally stops while the other is operating, without the valve between the condenser and the tunnel being closed, thus permitting a discharge of water through the pump in the reverse direction, experience indicates that the loss in vacuum corresponds to cutting the normal flow of water through the condenser in two. Apparently, only a small quantity of water escapes through the motorized pump.

Service obtained from motor-driven condensate air pumps has been satisfactory. Duplicate condensate pumps are usually installed, and if these are each driven from a different source of power, they should give reliable service considering the satisfactory manner in which the condenser will continue to function for a few minutes without the condensate pump running. The quite general use of the steam ejector for removing the air has furnished the simplest and most reliable form of apparatus and one to which there should be no objection from the viewpoint of service.

Boiler Auxiliaries

As the failure of an adequate supply of water for the boilers would cause serious damage to life and property, in all large stations built recently at least a duplicate set of pumps are installed, and in some of the initial sections of large stations greater leeway still has been provided. However, unlike excitation and circulating water, a short interruption to boiler-feed water is not serious, especially if caused by power supply failure, as in that case the boiler auxiliaries also would be liable to fail. With large steam drums, even with boilers operating at high ratings, there is a water supply for several minutes, and this has led to a more general use of electrically driven boiler-feed pumps adequately protected by steam-driven pumps.

A short interruption to the stoker drive and quite a long interruption to a clinker-grinder drive is permissible, so that service from house transformers should be satisfactory. The same source should offer a satisfactory supply for fans if an emergency source of supply is provided. In fact, there is some advantage in having the fans and stokers stop automatically if the load on the main unit is lost.

Powdered-Fuel Drives

One peculiarity of the powdered-coal boiler is the rate at which the steam output will vary when the amount of fuel is increased or decreased, provided there is sufficient air present for proper combustion. In the indirect method of firing this means that special attention must be paid to the motor drives for the feeders to guarantee a reliable source of power. The amount of power required is small, and in order to get the required speed variation, the feeders are usually driven by direct-current motors. If this current is supplied by motor-generator sets, these should be driven by the most reliable source of alternating current in the power plant, and preferably there should be two sources of power. The primary air supply also should have an equally reliable supply of current, as in case of failure of the primary air, there is some danger of the feeders' clogging up. To take care of this emergency, steam jets are frequently installed to furnish enough vacuum to transport the coal successfully and feed it into the furnace. To conserve high-pressure steam, there would be an advantage in using compressed-air jets.

Coal-handling and ash-handling equipment, service and drainage pumps usually are operated by the cheapest form of motor and power available in the station, which frequently means the slip-ring motor running on power furnished by the house transformers.

Duplicate Units

In supplying the air for combustion, the use of two motors per fan enables the normal load to be carried efficiently and, in addition to providing a reserve motor in case of the burning out of the motor ordinarily used, usually provides a larger motor which can be used when excess capacity is desired. The reduction in power losses helps pay for the additional investment, which is a small percentage of the investment in boiler capacity. This may be necessary if light fans are selected, but if heavy slow-speed plate type fans are used, they will be found reliable.

In most plants equipped with stokers, there either is a common duct into which all forced-draft fans discharge, or, in case individual fans are provided per boiler, the ducts are interconnected so that with the failure of any fan the dampers between that boiler and its neighbor can be opened and the boiler operated while its particular fan unit is undergoing repairs.

Stoker and clinker-grinder motors are small and usually underloaded, so that they are seldom installed in duplicate. Spare motors usually are carried and can be put in place quickly.

*Excerpts from paper read before the Chicago Section of the American Society of Mechanical Engineers, Jan. 15, 1925.

Large Power Plant Planned for West Coast of Mexico

Plans for the construction of a 250,000 hp. hydro-electric plant near San Dimas, Durango, Mexico, which will make possible the development of manufacturing, farming and mining along the west coast of northern Mexico were announced by Charles Dunphy, head of the San Dimas Mining Co., First National Bank, San Francisco, Calif., an operating concern owning lands, mines and other interests in Mexico.

Details of the project were not disclosed but it was learned that the power plant will serve the state of Sinaloa and the greater portion of Durango. The project will be built in units of 10,000 hp. each. Tunnels, surveys and other preliminary work is well under way, according to the *Arizona Mining Journal.*

The present plans call for the first power transmission line to be constructed to Mazatlan, Sinaloa and the second to Culiacan.

Interlinking of Power Scheme Seen in Merger of Utilities

A move in the direction of superpower, or the interlinking of power companies for the distribution of power, is seen, according to press reports, in the fact that the Jersey Central Power & Light Co., of which A. E. Fitkin is president, made application to the Public Utilities Commission of New Jersey on Feb. 20, to merge twelve of the small electric, gas and water companies of northern New Jersey. The companies to be merged are:

The Central Jersey Power & Light Co., the Tri-County Electric Co., the Lakewood & Coast Electric Co., the Toms River Electric Co., the Consolidated Gas Co., Coast Gas Co., the Lakewood Gas Co., the Shore Gas Co., the Monmouth Lighting Co., the Shore Lighting Co., the City Gas Light Co. and the Lakewood Water Co.

Outlining the objects of the merger, Earl F. English, vice-president and chief engineer of the General Engineering and Management Co., which has a management contract for all the properties involved, said that the principal gains would be more economical and efficient management and operation, greater ease in obtaining funds and a possible reduction in rates to consumers. He said that it was expected later to tie in with various other electric companies, especially the Public Service Electric & Gas Co., the American Gas & Electric Co. and the superpower development under way across the northern boundary of the state in New York, and the contemplated Pennsylvania superpower development.

Pratt Institute Evening Work Open for Inspection

On Thursday evening, March 5, the School of Science and Technology of Pratt Institute, Brooklyn, will open its laboratories, shops and drawing rooms to afford the public a chance to visit the school and see the work of these evening classes in mathematics, physics, electricity, chemistry, mechanical drawing, machine design, strength of materials, structural design, steam engineering, automotive engine maintenance and repair, machine work and toolmaking, forge work, foundry practice, pattern-making and carpentry. The men in attendance in these courses now number 1,158. There will be no other public exhibition this year of the School of Science and Technology.

Raising Great Lake Levels Favored by Engineer

According to Rufus W. Putnam, United States district engineer at Chicago, artificial raising of the levels of the Great Lakes a foot or more is entirely practical, comparatively inexpensive, without disadvantage to Canada, and would benefit both navigation and power developments in the St. Lawrence River, the press reports.

While this task is of enormous magnitude, nothing ever having been attempted before on such a great scale, it is thought that it is entirely feasible to raise the waters of all of the Great Lakes by placing works in the narrow channels between them. Regulating or compensating works might be built in the Niagara River alone or in both the Niagara and St. Clair Rivers.

If regulating works were built, they might be of considerable help in the St. Lawrence, where a steady flow will be most desirable for power purposes, while if compensating works were installed they would merely raise the lake levels above what they are now and, after being once installed and the lake levels adjusted, would have no further influence on the run-off of the lakes.

By the wildest figure that might be advanced, it is stated, construction of this character would not cost more than $10,000,000 and would be of benefit to navigation and power if the St. Lawrence waterway becomes a reality. Treaty with Canada will be necessary if the construction crosses the Canadian boundary, which would be the case with regulating works. Compensating works, however, could be sunk in the St. Clair or Niagara Rivers without reaching to the other side, and would only require the approval of the International Joint Commission. Chicago, according to the engineer, should share in the cost of restoring the levels that its diversion has largely helped to reduce.

Shipping Board Wants Small Diesel Units

The United States Shipping Board is advertising for bids on forty-nine 75-kw. Diesel engine-generator units for auxiliaries for vessels that are being equipped with 3,000-hp. Diesels recently purchased by the Board. Bids must be received before March 6.

Valmont to Add New Unit This Year

To meet the expected demands for electric power in Colorado cities and the Moffat Tunnel, when completed and electrified, the Public Service Company of Colorado is planning to double the capacity of its present plant at Valmont, a steam power station, near Boulder, which has cost $5,000,000 to date, by adding a second unit to cost approximately $750,000, according to H. H. Kerr, superintendent of the electrical department of the company. The first unit of 20,000-kw. capacity was put into service Nov. 30, 1924. A dam 3,500 ft. in length, with five subsidiary dams, to cost about $1,100,000, also is planned. Construction on both projects will be started in the present year, as bids have already been requested. A third unit will be added to the Valmont plant in 1928 or 1929 according to the present plans of the company.

Fuel-Saving Conference and Power Show Planned

There will be held the annual Fuel Saving Conference and in connection with it a Power Show, under the auspices of the combustion engineering division of the Association of Iron and Steel Electrical Engineers, May 13 and 14 at the William Penn Hotel, Pittsburgh, Pa., at which all manufacturers of power apparatus will be given an opportunity to display their equipment.

For particulars as to space, details, etc., application can be made to W. P. Chandler, Carnegie Steel Co., Pittsburgh; Walter Flanagan, Ohio Works, Carnegie Steel Co., Youngstown, Ohio; H. C. Seibert, Bethlehem Steel Co., South Bethlehem, Pa.; S. Kneass, Jr., Youngstown Sheet & Tube Co, Youngstown, Ohio; G. R. McDermott, Illinois Steel Co., South Chicago, Ill.; F. G. Cutler, Tennessee Coal, Iron & Railroad Co., Ensley, Ala.; A. G. Witting, Illinois Steel Co., Gary, Ind.; E. W. Trexler, Bethlehem Steel Co., Johnstown, Pa.; W. J. Harper, Donner Steel Co., Buffalo, N. Y.; C. H. Hunt, Weirton Steel Co., Weirton, W. Va.; J. C. Allen, Carnegie Steel Co., New Castle, Pa.; A. Steed, American Rolling Mills Co., Middletown, Ohio; John F. Kelly, manager, A. I. & S. E. E., Empire Bldg., Pittsburgh, Pa.

Court Enjoins Storing Water for Florence Lake Tunnel

In an opinion of the Superior Court of Fresno County, Calif., filed Feb. 13, 1925, the Southern California Edison Co. has been enjoined from storing water in Huntington Lake on its Big Creek hydro-electric project except that which is produced by the run-off in the Huntington Lake basin. This in effect means that water stored in the Florence Lake, Vermillion Valley, and Blaney Meadows reservoirs on the so-called east side development cannot be carried through the recently completed Florence Lake tunnel, or a proposed tunnel and held in storage in Huntington Lake, or Shaver Lake for use through the chain of Big Creek power houses, now numbering four with an aggregate capacity of 238,000 kw., but must be allowed to flow on into the San Joaquin River so that the normal flow of that stream will be unaffected.

The decision in like manner prevents the storage of water along the middle fork of the San Joaquin on the west side development, as yet not undertaken. The Herminghaus heirs, owners of a tract of land along the San Joaquin River in the valley, brought suit against the power company under the name of Mrs. Amelia Herminghaus on the grounds that the storage of water for power purposes on the upper reaches of the river prevents the normal spring floods from overflowing the lowlands of the estate and replenishing the supply of ground water necessary to the use of the land.

One of the main points of contention of the power company was that as lessees of water rights from the federal government it was entitled to the riparian rights of the government in the public domain. Superior Judge Woolley agreed with this contention, but he held that the storage of water for the generation of power was not an incident of riparian ownership. It was the opinion of irrigationists of the San Joaquin Valley that the storage of the spring run-off in the mountains was both necessary and beneficial because such flood waters have no present or future beneficial use to riparian owners in the lowlands. In the opinion of J. F. Truesdell, assistant to the attorney general, appearing for the government, the government has the power as riparian owner of the public domain to store waters from a wet to a dry season.

In a statement issued by John B. Miller, president of the Southern California Edison Co., following the decision he said that the case would be immediately appealed and that work would continue in the meantime on the Big Creek-San Joaquin hydro-electric development along the lines originally intended by that company. This means that construction work will continue on the Florence Lake dam and upon such other units of the project as had been contemplated for 1925.

In the opinion of lawyers versed in water law who have followed the case, condemnation proceedings will have to be resorted to by the Edison company if the court decision is upheld in the higher courts.

Funds for Arch Dam Tests Secured

As the result of subscriptions totaling more than $60,000 construction work is to begin on the experimental arch dam sponsored by the arch dam committee of Engineering Foundation as soon as details of construction can be worked out. Funds already subscribed total $61,700 which will be sufficient for the first series of tests.

The site tentatively chosen is on Stevenson Creek, a tributary to the San Joaquin River in central California. The nearly vertical rock walls of the creek canyon will keep down the impounded water to only a few acre-feet, the flow of the creek from Shaver Lake will be easily controlled. The purpose of the test dam is to secure much needed data on the design of such structures. Although arch dams have been used for centuries, their design is still largely a matter of theory, and it is not known what factor of safety actually exists. With the data that will be made available from tests on this experimental arch dam, together with the results of research by Engineering Foundation on deflection and other deformation of existing dams, it should be possible to design structures and build them at a minimum of cost consistent with an ample factor of safety. It may thus be possible to construct dams for power and irrigation projects that are not now economically feasible.

Jerry Dwyer and dog team used to carry mail and supplies to crews blasting and drilling Florence Lake Tunnel of the Southern California Edison Co. at Huntington Lake, Calif.

Hydro Plant May Be Built in Chile

There is a possibility that a 30,000-hp. hydro-electric plant will be built at Huilo-Huilo Falls, Chile, and perhaps it may later be increased to 120,000 hp. Details may be obtained from the electrical equipment division, Bureau of Foreign and Domestic Commerce, Washington, D. C., by referring to Report No. 154341.

West Penn Co. Adds Unit to Springdale Station

The West Penn Power Co. has just placed an $800,000 contract for an additional unit to be installed in its Springdale, Pa., plant. The addition will consist of one 40,000-kw. Westinghouse turbine generator and a 62,000-sq.ft. Westinghouse condenser. It will be similar to the other power units in the station, although the rating is smaller. The addition to the station is in keeping with the superpower plans of the West Penn Co. and forms a part of its eastern nucleus. Recently, two units similar to the one just ordered, were installed in the Springdale plant and have just been placed in operation. The rapid expansion of this station indicates the tremendous power-load growth in western Pennsylvania.

Muscle Shoals Bill Sent Back to Conferees

The Muscle Shoals bill was put in serious jeopardy Feb. 23, when it was sent back to conference by formal action in the Senate. It is understood that the conferees are unwilling to agree to the Underwood bill in the exact form in which it passed the Senate. Any effort that they may make to perfect the measure carries with it the possibility of another point of order against it. In such an event the time is thought to be too short to permit of the passage of the bill before the end of the session on March 4. As this is written, it is said to be the intention of the conferees to alter the bill and report it promptly to the Senate.

When the conference report on the Muscle Shoals bill came before the Senate, Senator Norris immediately made a point of order against it on the ground that the conferees had inserted new matter and were attempting to legislate by means of a conference report, procedure prohibited by the rules of the Senate. The presiding officer sustained the point of order made by the Nebraska Senator. Senator Underwood appealed from the decision of the chair. This resulted in protracted debate as to the parliamentary situation involved, but finally the chair was sustained in a close vote of 45 to 41.

In response to a question by Senator Underwood the presiding officer held that the bill must be referred to the same conferees as had previously reported on it.

Coal Replacing Oil as Fuel on Baltimore Ships

The use of four coal-burning ships in place of oil burners on the Baltimore line of the Emergency Fleet Corporation was approved Feb. 18 by President L. C. Palmer, in accordance with the recommendation of R. T. Merrill, director of the Baltimore district of the corporation. This approval is given on the basis of a maximum estimate of $100,000 as the cost of reconditioning the ships, which for several years have been in the "laid up" fleet.

The substitution of coal for oil has been brought about because of the big fuel saving possible by the use of coal. Government engineers estimate that the entire cost of placing the coal burners in condition will be recovered in less than 18 months through saving in fuel. It is predicted that several more oil burners will be retired from the Baltimore line in the near future and it is likely that consideration will be given to the increased use of coal burners on the three New York lines of the corporation. The ships of the Baltimore line operate to United Kingdom ports, and when the four additional coal burners are put in shape there will be eleven coal burners on this line as against ten oil burners.

Engineering Foundation Plans Endowment Increase

Increase of the endowment of the Engineering Foundation, through which scientific research work is carried on by the organized engineering profession of the country, was proposed at the annual meeting of its board held on Feb. 18. Farley Osgood, president of the A. I. E. E., brought forward a proposal that the endowment be increased from the present sum of $550,000 to $20,000,000.

"If our country is to continue to progress," said the announcement, "the advance of the engineering profession cannot be slackened. If professional progress is to go on, the national societies must have the benefit of a sustained, considered, co-ordinated program of research."

At the meeting Lewis Buckley Stillwell, New York engineer, was elected chairman. He succeeds Charles F. Rand, who declined re-election after serving five years. Edward Dean Adams was elected first vice-chairman. Elmer A. Sperry, gyroscope inventor, was chosen second vice-chairman. Other officers elected were J. S. Langthorn, treasurer; Henry A. Lardner, assistant treasurer; Alfred D. Finn, director and secretary.

The following were elected to the board as trustees of the United Engineering Society; George H. Pegram, A. S. C. E.; J. Vipond Davies, A. I. M. and M. E.; W. F. M. Goss, A. S. M. E.; Bancroft Gherardi A. I. E. E.

These eight members nominated by the governing bodies of the founder societies were chosen; Edward Dean Adams, Robert Ridgway, Arthur L. Walker, H. M. Boylston, Arthur M. Greene Jr., George A. Orrok, Gana Dunn, L. B. Stillwell.

Elmer A. Sperry, Charles F. Rand and Arthur D. Little were named members at large. W. L. Saunders, chairman of the Naval Consulting Board, will be a member ex officio as president of the United Engineering Society.

Much Agitation Regarding Barge Canal Power

Bills by both the Democratic and the Republican leaders in the legislature of New York State regarding the sale of power generated at Crescent Dam and Vischer Ferry on the Barge Canal owned by the state, were introduced recently. The power generated on the canal, under the law as amended in 1923, can be sold only to municipalities. The municipalities that could avail themselves of this privilege are already under contract to power companies for power and light and cannot take advantage of the provisions of the law.

To remedy this defect and prevent the power going to waste the state engineer and surveyor, after conference with the superintendent of public works, has had a bill prepared which was introduced in the Senate on Feb. 20, by James S. Truman, amending Chapter 532 of the Laws of 1922 so as to permit the sale, to the highest bidder, of the electric current generated on the Barge Canal, whether the bidder be a corporation, a private business or a municipality. At the conference of mayors of the capitol district cities, it was brought out that Henry Ford at his Green Island plant near Troy and the New York Central Railroad in the development of its Selkirk yards south of Albany might be potential buyers of this power.

Weeks Holding Hearings on Chicago Diversion

Reassured by an opinion from the Department of Justice, the Secretary of War has entered upon hearings in the matter of diversion from Lake Michigan at Chicago, convinced that he has full authority, under the circumstances, to issue a temporary license prescribing the conditions under which this water may be used. It seemed apparent from Secretary Weeks' questions that the permit would be so arranged as to insure active work on the part of the Chicago authorities looking to the reduction of the amount of the diversion.

It is expected that a permit for five years will be granted. One of the conditions probably will be that sewage disposal for 1,200,000 persons be provided in that time. At the end of that period a better conception of the entire project will be possible. Such a condition, it is pointed out, would provide for the completion of less than one-fourth of the entire sewage-disposal project when the probable growth of the city over a twenty-year period is considered.

The hearing was confined largely to the really vital points at issue. The development of power at Chicago and other minor matters came in for incidental mention only. It was shown that no great amount of profit comes from power development at Chicago, but it also was brought out that this enterprise has political value through the relatively large number of patronage places it provides.

Mexico and the Colorado River Problem

Opinion in Washington is divided as to the best course to pursue in the matter of the international aspects of the development of the Colorado and Rio Grande Rivers. The Minister of Foreign Relations for Mexico has issued a statement to the effect that Mexico does not desire to consider alone the equitable distribution of the waters of the Rio Grande and would like to consider that question in conjunction with the distribution of the waters of the Colorado.

While the principle of the prior appropriation and beneficial use of water applies as between states of the Union, it is contended that this principle is not applied internationally. In fact, the State Department policy is based on an opinion by Attorney General Judson Harmon which sustains that point of view. As applied to the Colorado, it would mean that Mexico would acquire no prior right by putting water to beneficial use if the water of the river should be increased before lands on the lower river in American territory were ready to make use of the water.

Regardless of the letter of international law, other officials point to the fact that the United States almost without exception has made concessions when dealing with a smaller or weaker country. If the low-water flow of the Colorado is increased, it is certain that it will be put to beneficial use in Mexico, where there is a large acreage that can be easily and quickly developed as the Colorado is regulated. While it may be in entire accordance with international law for the United States subsequently to deny this increased water supply to the lands below the Mexican border, it is practically certain, some officials declare, that no such step will be taken. For that reason they urge that the treaty negotiations, which were interrupted in 1913, be resumed at the earliest moment.

On the other hand, there are officials who believe it to be entirely unnecessary to have any understanding or treaty with Mexico dealing with the American development of the Colorado River. Under international law, they point out, the United States has absolute and exclusive jurisdiction over the Colorado River within our territorial limits. In similar fashion, however, Mexico controls important tributaries of the Rio Grande.

The whole question is being considered actively by the State Department at this time. It is expected that a policy that will be pursued in connection with the Rio Grande and the Colorado will be worked out in the near future.

There were sold during January of 1925, 57 mechanical stokers installed under four fire-tube boilers of 8,700 sq.ft. of heating surface and 53 water-tube boilers of 270,010 sq.ft. of heating surface, according to figures compiled by the Department of Commerce, from reports received from 13 establishments.

Power Plant Engineering Course for County School

The Essex County Vocational School for Boys, Newark, N. J., has arranged a course of study in power-plant engineering, consisting of a series of about 18 lessons to be given two nights each week. No charge is made for the instruction, the only requirement being a registration fee of one dollar, to be returned at the close of the course where the individual's attendance has been satisfactory. The course is designed primarily for assistant engineers, firemen, oilers and helpers. The school is provided with a modern steam-power plant.

Symposiums on Corrosion and Flames for A. C. S. Meeting

The division of industrial chemistry of the American Chemical Society will hold a symposium on corrosion during the sixty-ninth meeting of the society, which will be held in Baltimore, April 6-10. The symposium will begin on Wednesday morning and will be joined in by the petroleum division. Contributions to this symposium will be made by W. R. Whitney, W. D. Bancroft, W. H. Bassett, Guy D. Bengough and Ulrick R. Evans.

The gas and fuel division will hold a symposium on flames. The discussion will include some of the fundamental theories in regard to flames as well as a summary of fuel research in Europe.

M. I. T. Offering Course in Gas and Fuel Engineering

The Massachusetts Institute of Technology, in line with other universities, has decided to offer a new graduate course in gas and fuel engineering. The reason as given by R. T. Haslam and J. T. Ward, of the department of chemical engineering in *The Tech Engineering News*, is that the development of means for the efficient production and use of heat and power has become one of the principal engineering problems of this generation. Coal, petroleum and water power comprise the three major sources from which we may expect to supply our constantly increasing requirements of energy. The work in gas and fuel engineering will consist of an academic year devoted exclusively to classroom work and lectures, which will be followed by six months' experimental work in industrial plants. At the outset the experimental work will be carried out in two field stations.

The master's degree in gas and fuel engineering will be awarded on completion of this part of the course. Further study and research work will lead to the doctor's degree.

Some of the important graduate subjects that will form a part of the course are: Gas engineering, primary fuels, secondary fuels, combustion of fuels, furnace and retort design, development and use of power, power-plant design and equipment, refractories, materials of construction, economic geology of fuels, economics of the gas industry and rate making, distribution of manufactured gas, internal-combustion engines and gas appliances.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Convention at Orlando, Fla., June 2-5.

American Association of Oil Burner Manufacturers. Leod D. Becker, Bank of Galesburg Bldg., Galesburg, Ill. Convention and exhibit at Edgewater Beach Hotel, Chicago, April 1-3.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Niagara Falls, April 23-25.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at St. Louis, April 13-17. Annual convention at Saratoga Springs, June 22-26.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, June 22-26.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Water Works Association. W. N. Niesley, 170 Broadway, New York City. Convention at Louisville, Apr. 27-May 3.

Canadian Association of Stationary Engineers. Geo. J. Soucy, 48 Moore Ave., Toronto, Ont., Secy. Convention at Windsor, June 29-July 1.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at Hot Springs, Va., May 26-29.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th St., New York City, April 27 to May 2.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

Mid-West Power Show at Milwaukee, Wis., May 18-21. Ralph H. Cahill, care of Mid-West Power Show, City Hall, Milwaukee, Wis.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Kansas Association** at Topeka May 6-8. J. M. Van Sant 739 Horne St., Topeka. **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **New England States Association** at Worcester, Mass., July 10-12, formerly announced June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association at Muskegon,** July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago. National convention at Hotel Winton, Cleveland, Ohio, May 6-8.

Obituary

Edward S. Gilmore, superintendent of the steam service of the Westinghouse Electrical & Manufacturing Co., with headquarters at Denver, Colo., died Feb. 18 at the Phelps-Dodge Corporation Hospital, Dawson, N. M. Mr. Gilmore had been connected with the Westinghouse company since 1902, going to Denver from Chicago about four years ago. His last work in Colorado was the installation of the big steam turbines of the Public Service company's $5,000,000 plant at Valmont, Colo. He was a Mason. Surviving him are his widow and three daughters.

Personal Mention

S. J. Blatchford, formerly general manager of Bice Engine & Service Co., will take charge of sales and construction for the Power Boiler Co. at its new office, 90 West St., New York City.

J. V. Reynders, New York City, was elected president of the American Institute of Mining and Metallurgical Engineers at its convention held in New York City recently.

W. A. Shoudy, 50 Church St., New York City, has recently been retained by the Bailey Meter Co., Cleveland, O., as consulting engineer. Mr. Shoudy retains his connections as advisory engineer to the Adirondack Power & Light Corp., Schenectady, and as associate in mechanical engineering at Columbia University.

Robert E. Dillon, widely known in the steam-plant operating field, has been appointed superintendent of the generating department of the Edison Electric Illuminating Co. of Boston, Mass., succeeding the late Charles H. Parker, and **Frederick D. Knight** has been named as assistant superintendent, the position formerly occupied by Mr. Dillon.

Society Affairs

The Ontario Section of the A.S.M.E. will hold a meeting on March 11. The subject will be "Elevators," by E. M. Benton, of the Westinghouse Company.

The Metropolitan Section of the A.S.M.E. will hold a joint meeting on March 11, with five national engineering societies at which the subject will be "The Engineer as an Executive."

The Los Angeles Section of the A.S.M.E. will hold its field day at the Edison power plant at Long Beach on March 21. The subject for discussion will be "Improvements in Power Plant Equipment."

The Baltimore Section of the A.S.M.E. will hold a meeting on March 11 at which H. P. Benjamin, president of the Benjamin Engineering Co., Cleveland, will speak on "Combustion Control."

The New England States Association of the N.A.S.E. will hold its convention at Worcester, Mass., July 10-12. This convention was formerly announced for June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass., is the secretary.

Business Notes

The Pennsylvania Crusher Co., Stephen Girard Bldg., Philadelphia, Pa., announces the recent appointment of the Stratton-Cahoon Co., 809 McIntyre Bldg., Salt Lake City, Utah, as its district agent for the sale of coal-preparation machinery.

The Combustion Engineering Corp., Broad St., New York City, announces the appointment of W. R. Quinn, former manager of the fuel-oil department, as Pacific Coast agent, with headquarters in San Francisco. This territory will include Washington, Oregon and California.

The Standard Turbine Corp., Scio, N. Y., announces the appointment of Starkweather & Broadhurst, 79 Milk St., Boston, Mass., as its Boston representative; J. F. Shouse & Co., 70 Kenyon Bldg., Louisville, Ky.; and Bradley T. Johnson, 708 Mutual Bldg., Richmond, Va.

The S. Morgan Smith-Inglis Co., Toronto, Canada, the new corporation which was organized during the past year to manufacture hydraulic turbines in Canada, and which is composed of the S. Morgan-Smith Co., York, Pa., and the John Inglis Co., Toronto, as announced in the Nov. 4, 1924, issue, has as its president, William Inglis, president of the John Inglis Co., and as vice-president, Elmer Smith, president of the S. Morgan-Smith Co.; and the directors include C. H. Fierheller, secy.-treas. of the John Inglis Co., H. B. Van Every, and D. J. McCormack, hydraulic engineer of the S. Morgan-Smith Co.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	Feb. 23, 1925
Pool 1	New York	$2.50@$2.90
Smokeless	Boston	1.72
Clearfield	Boston	1.75@ 2.20
Somerset	Boston	1.90@ 2.35
Kanawha	Columbus	1.40@ 1.60
Hocking	Columbus	1.35@ 1.65
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.25@ 1.35
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.75
S. E. Ky.	Louisville	1.25@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	$2.25@$3.15
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.40@ 1.65

FUEL OIL

New York—Feb. 26, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 1, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5.5c. per gal.; 38@40 deg., 6@6.5c. per gal.

Pittsburgh—Feb. 25, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Dallas—Feb. 24, f.o.b. local refinery, 26@30 deg., $1.90 per bbl.

Philadelphia—Feb. 25, 28@30 deg., $2.73@$2.793 per bbl.; 18@22 deg., $2.42@$2.483; 13@16 deg., $2.10@$2.163 per bbl.

Boston—Feb. 21, tank-car lots, f.o.b.; heavy oil, 12@14 deg.. Baumé, 4⅝c. per gal.; light oil, 28@32 deg. Baumé, 6c. per gal.

Cincinnati—Feb. 24, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Trade Catalogs

Mills, Unit-Air Ball—The Bonnot Co., Canton, Ohio. Bulletin No. 64 describes the development of the unit-air ball mill for firing boilers. Diagrams and photos of the equipment and installation of this method of preparing pulverized coal for direct firing of boilers, are included.

Turbines, Kerr—Elliott Co., Wellsville, N. Y. Catalog H, "Kerr Turbines for Generator Drive," describes in detail the constructional features of these turbines. Sectional views, including those of the automatic bleeder mechanism, mixed-pressure governor and reduction gears are shown, as well as photos of installations.

Boilers—Nuway Boiler and Engineering Co., 53 West Jackson Boulevard, Chicago, Ill. A treatise on boiler-water circulation and the advantages of the rapid circulation of the water has recently been issued by this firm. A table of chimney sizes and the various stages of the development of the steam boiler from the tea kettle to the latest design are given. Copies may be obtained upon application.

New Plant Construction

Ala., Bay Minette—Baldwin County Electric Light & Power Co., filed a petition with the Alabama Public Service Commission, Mobile, for permission to construct an electric generating plant, and distributing system in Baldwin County.

Ala., Huntsville—Huntsville Realty Co. is having plans prepared for the construction of a 10-story office building, with heating plant, on the old McGee Hotel site. Estimated cost $500,000. R. H. Hunt & Co., Chattanooga, Tenn., is architect. Engineer not selected.

Calif., Emeryville—Pacific Gas & Electric Co. 445 Sutter St., San Francisco, plans the construction of a substation, here. Estimated cost $125,000. Company engineers are in charge.

Calif., Oakland—County of Alameda, will soon receive bids for the construction of a power house, with boiler plant, garage, and laboratory, for the county hospital. Estimated cast $200,000. H. H. Meyers, Kohl Bdg., San Francisco, is architect.

Calif., Salinas—Coast Valleys Gas & Electric Co., 11 East Gabilan St., plans improvements with funds provided for in 1925 budget. The plans include the construction of a substation, estimated cost $200,000, electric lines, transformers and meters, $244,195. Also new substation equipment at Soledad, $7,840; construction of new substation at Gonzales, $18,000; and new substation transformers at Monterey, $15,000.

Calif., San Diego—F. W. Stevenson, 533 Spreckels Bldg., Archt., has completed plans for the construction of a 10 story office building, including steam heating plant, on 11 and C Sts., for corporation not yet formed. Estimated cost $590,000. Building to be for use of the San Diego County Medical Association.

Calif., San Francisco—New York Community Apartment, House, Inc., G. A. Shaffer, 560 Sutter St., interested, is having plans prepared for the construction of a 10 story, apartment house on Hyde St. Estimated cost $500,000. W. F. Gunnison, 57 Post St. is architect.

Calif., Santa Rosa—Bd. of Public Utilities, G. R. Cadam, Secy., is in the market for turbine pump, with electric motor direct connected, 1200 r.p.m., 440 v. 60 cy.

Colo., Denver—Midland Savings & Loan Co. 17th and California Sts., will receive bids in March, for the construction of a 5 story bank and office building, at 17th and Glenarin Sts. Estimated cost $500,000. Fisher & Fisher, U. S. National Bank Bldg., are architects.

D. C., Washington—Wardman Construction Co., 1430 K St., is having plans prepared for the construction of an office building, at 1300 Connecticut Ave. Estimated cost $1,000,000. Wardman and Waggaman, 1430 K St. NW., are architects.

Fla., Miami Beach (Miami P. O.)—N. B. Roney, is having plans prepared for the construction of a hotel on Ocean Drive, between 23rd and 24th Sts. Estimated cost $1,500,000. L. Schultz, Schultz & Weaver, 17 East 49th St., New York City, is architect.

Fla., Sarasota—M. F. Schiavoney, 10 East La Salle St., Chicago, Ill., plans the construction of a 12-story hotel, on Main St., here. I. Beeker, Sarasota, is manager.

Ill., Lake Forest—Water Dept., City Hall, Clk., will receive bids until March 16th for pumping equipment.

Ind., East Chicago—Bd. of Public Works, will receive bids until March 18 for the construction of sewage pumping station, with equipment and accessories, on Alder St. Greeley & Hansen, 6 North Michigan Ave., Chicago, Ill., are consulting engineers.

Ia., Cedar Rapids—Merchants National Bank, 3rd Ave. and South 3rd St., will take bids in April for the construction of a 12 story, office building, at 2nd Ave. and 3rd Streets East. Estimated cost $1,000,000. Weary & Alford 1923 Calumet Ave., Chicago, Ill. is architect.

Ia., Sioux City—Sioux City Gas & Electric Co. awarded contract for the construction of a power station, to U. G. I. Contracting Co., Broad and Arch Sts., Philadelphia, Pa. Estimated cost $2,000,000. The plans include two, 10,000 kw. General Electric turbines; three 1,100-hp. Stirling boilers, fired by pulverized coal, also boiler room, turbine, room, and preparation room for coal, service building, etc.

Ia., State Center—City, is having plans prepared for the construction of a waterworks system, including reservoir, pumping station, filtration plant, and elevated tank. Estimated cost $50,000. Brown & Cook, Ottumwa, are engineers.

La., Baton Rouge—Baton Rouge Electric Co. has awarded contract for increasing capacity of plant by installation of 35,000 kw. turbo generator, to Stone & Webster, Inc., 147 Milk St., Boston, Mass. Building will be extended and spray pond enlarged but no increase in boiler capacity is needed.

Mass., Canton—Water Commission plans the construction of pumping station and stand pipe, on Hogh St., also elevation of

Ponkapoag standpipe. Estimated cost $15,000. Engineer not selected.

Mass., Lowell — Lowell Electric Light Corporation, 20 Market St., awarded contract for the design and construction of a steam station on Perry St., to Stone & Webster, Inc., 147 Milk St., Boston. Plans include a 12,000 kw. turbo generator, equipped with surface condenser and auxiliaries.

Mass., Springfield—United Electric Co., plans the construction of an electric light station on Wilbraham Ave. Engineer not selected..

Mich., Detroit—Peter Miller, 111 Putnam Ave., is having plans prepared for the construction of a 12-story hotel, with steam heating system, electric equipment and elevators, on Kirby Ave. Estimated cost $2,500,000. Halpin & Jewell, 1024 Hammond Bldg., are architects.

Mich., Detroit—B. A. Scott, 1710 Ford Bldg., has had plans prepared for the construction of a 7 story hotel, including steam heating system, elevators, etc., at Canfield and Woodward Sts. M. H. Finkel, 1333 Book Bldg., is architect.

Mich., Detroit—Union Trust Co., Union Trust Bldg., Griswold St. F. W. Blair, Pres. plans the construction of a 16-story office and banking building, including steam heating system, and lighting equipment on recently acquired site on Griswold St. Architect not selected.

Mo., Bagnell — Missouri Hydro Electric Co., W. Cravens, Pres., Kansas City Joint Stock Land Bank, Kansas City, is having plans prepared for the construction of a hydro-electric plant including dam, 2,450 ft. long, and 140 ft. high, with 1,500 ft. spillway, across the Osage River. 7 miles from here. Estimated cost $10,600,000. Burns & McDonnell, 402 Interstate Bldg., Kansas City, are engineers.

Mo., Kansas City—Bd. of Fire and Water Comrs. A. J. Stewart, Pur. Agt. City Hall, will receive bids until March 21 for furnishing and constructing a high lift pumping station, in East Bottoms, on Nicholson Ave., near Monroe St. The station is designed for three, 24 m.g.d. electric motor driven pumping units, a covered equalizing reservoir, with a capacity of 17,000,000 gal. also meter chamber, valves, piping, conduits, and other appurtenances. Fuller & Maitland, 600 Walnut St., are engineers.

Mo., Kansas City—Fisher Building Co., 618 Commerce Bldg., awarded contract for the construction of an 8-story apartment house, on Locust St., to Patti-Moore Construction Co., 411 Jenkins Bldg. Estimated cost $500,000.

Mo., St. Louis—Roxana Investment Co. care of Roxana Petroleum Corp., Arcade Bldg., awarded contract for the construction of a 12-story office building, on Locust and Thirteenth Sts. to Gamble Construction Co., 620 Chestnut St. Estimated cost $500,000.

Mo., St. Louis—Widmer Engineering Co., Laclede Gas Light Bldg., Engrs. and Archts., was awarded contract for the construction of a 16 story office building, at Fourth and Locust Sts. Owners' name withheld.

Mo., St. Louis—E. M. Worthington, 324 Belt Ave. will build two, 9 story apartments at Taylor and Maryland Aves. Work will be done by separate contracts under supervision of owner. T. L. Craven, Century Bldg. is engineer. W. S. Frank, Century Bldg. is architect.

N. J., Camden—Edward R. Solomn, Inc. plans the construction of a 10 story office building, on Sixth and Cooper Sts. Engineer not selected.

N. J., Newark—Permanent Industrial Exposition of Newark, Inc., L. V. Aronsen, 36 Park Pl., Pres. awarded contract for the construction of a 6 story office building, at Broad and Pennington Sts. to Thompson Starrett Co., 250 Park Ave., New York City. Estimated cost $2,000,000.

N. J., Trenton—City Water Dept., A. Swan, Comr., plans the construction of a water service station, including pumping equipment and tank. Estimated cost $60,000. Alvin Bugbee, City Hall, is engineer.

N. Y., Buffalo—Supt. of Lighthouses, Federal Bldg., will receive bids until March 16 for one, 34-hp. engine generator unit.

N. Y., Coney Island (Brooklyn P. O.)—J. Palmieri, 63 Park Row, New York, plans the construction of a hotel at West 31st St. and Boardwalk, here. Estimated cost $3,000,000. Engineer and architect not selected.

N. Y., New York—464 Corporation, c/o H. C. Severance, 36 West 44th St. Archt. and Engr. is having plans prepared for the construction of a 19 story hotel, on Seventh Ave. Between 50th and 51st Sts. Estimated cost $2,000,000.

N. Y., New York—Lutheran Hospital, 341 Convent Ave. plans the construction of a hospital building, on Convent Ave. Estimated cost $2,000,000. Engineer and architect not selected.

N. Y., New York—N. Natanson, c/o H. C. Severance, 36 West 44th St., Archt., is having plans prepared for the construction of a 7-story office building at Madison Ave. and 49th St. Estimated cost $500,000.

N. Y., New York—Primo Building Corporation, c/o Author's League of America, Inc., 2 East 23rd St., is having plans prepared for the construction of a 20 story apartment house, at 34th St. and Lexington Ave. Estimated cost $2,500,000. E. Fairchild, 2 East 23rd St., is architect.

N. Y., Utica—State Hospital Commission, Capitol, Albany, will receive bids until March 25 for repairs to heating plant and installation of electric elevator in main building, here. S. W. Jones, Capitol, Albany, is state architect.

O., Canton—City plans the development of new water source, including wells and pumping equipment. Estimated cost $150,000. W. E. Sarver, City Bldg., is engineer.

O., Cleveland—City will soon receive bids for the following improvements: rebuilding of four triple expansion engines, for 250 lb. steam pressure, and 250-ft. water head; four, 700-hp. vertical water tube boilers with underfeed stokers; removing old boilers and revamping boiler room in basement; forced draft fans; forced draft air duct; coal and ash handling equipment, feed water heater, and boiler feed pump, stoker drives and piping; water softener equipment; power pipi.g; main switchboard and electric valve control; gages and meters; pipe covering, etc. Estimated cost, $400,000. L. A. Quayle, City Hall, is engineer.

O., Cleveland — Cleveland Electric Illuminating Co., c/o E. J. Cook, Illuminating Bldg., awarded contract for the construction of a 4-story 74 x 160 ft. substation at 737 Bolivar St., to Lundoff-Bicknell Co., B. F. Keith Bldg. Estimated cost $300,000. Private plans.

O., Cleveland—Elyria Iron & Steel Co., 232 East 131st St., H. B. Wids, Pres., plans the construction of factory addition, with boiler house, on East 131st St. Estimated cost $200,000. Equipment includes, two, 100-hp. boilers, E. McGeorg, 303 Euclid Ave., is engineer and architect.

O., Cleveland — Lakeside Hospital — c/o M. P. Potter, Secy. of Building Commission, Adelbert Rd. awarded contract for the construction of a 10 story, nurses home, on Cunningham Rd. to Lundoff-Bicknell Co., B. F. Keith Bldg., Cleveland. Estimated cost $750,000.

O., Cleveland — The Motors Realty Co., c/o Ohio Buick Co., 1903 East 19th St., G. G. Peckham, Pres., is taking bids for the construction of a 10-story garage and office building, including steam heating system at Euclid Ave. and East 24th St. Estimated cost $1,000,000. W. S. Ferguson Co., 1900 Euclid Bldg., is architect.

Okla., Blair—City, will hold an election March 17th to vote on $30,000 bonds for waterworks system, including drilled well, pump, elevated tank, mains, etc. Engineer not selected.

Okla., Holdenville — City is having preliminary surveys made for the construction of a new pumping station, reservoir, pumping equipment, mains, etc. Estimated cost $80,000. Bond election will be held in March. V. V. Long & Co., Oklahoma City, is engineer.

Okla., Idabel—City, will hold an election on March 17th to vote $23,000 bonds for motor driven pumps, oil engine, transmission lines and 250 water meters. V. V. Long & Co., 1300 Colcord St., Oklahoma City, are engineers.

Okla., Perry—City, B. R. Lucas, Clk., will receive bids until March 11, for one, 350 hp. Diesel oil engine generator unit, with switchboard, exciter, power wiring, fuel tank, cooling tower and starting appliances. Estimated cost $40,000. A. W. Yoce, is engineer.

Pa., Pittsburgh—Children's Hospital, awarded contract for the construction of an 8 story hospital, on DeSoto St., to W. T. Grange Construction Co., Keenan Bldg. Estimated cost $1,500,000.

Pa., Pittsburgh—Mercy Hospital, Stevenson St., will receive bids until March 11th, for the construction of a 9-story nurses home. Estimated cost $600,000. E. M. Stotz, Monongahela Bank Bldg., is architect.

S. C., Spartanburg—Broad River Power Co., Columbia, plans an outdoor 10,000 kva. transformer station fed from two, 114,000-volt lines, stepping down to 33,000 volts and 13,200 volts; three, 3,333-kva. transformers with necessary switching equipment. Estimated cost $200,000. Company engineers in charge.

Tenn., Nashville—Cotton States Life Building. C. Lorigans, Pres., Stohlman Bldg., is having plans prepared for the construction of a 10-story office building, at 6th Ave. and Deaderick St. Estimated cost, $500,000. Marr & Halmon, Stohlman Bldg., are architects.

Tenn., Nashville—Southern Insurance Co. plans the construction of an office building, on recently acquired site on Eighth Ave. between Church and Broad Sts. Estimated cost $500,000. Architect not selected.

Tex., Corpus Christi—New State Hospital, c/o V. M. Donigan, awarded contract for the construction of a 4 story hospital, to Wagnen & Son, San Antonio. Estimated cost $600,000.

Tex., Houston—Fidelity Trust Co., 808 Main St. W. W. Moore, Pres. plans the construction of a 12 story office building on Main St. Estimated cost $800,000. Architect not selected.

Tex., Houston—C. J. Gerner, 4401 Montrose Ave. awarded contract for the construction of a 5 story apartment house, on Montrose Blvd., to F. B. Hubbard Construction Co., 737 Banker's Mortgage Bldg. Estimated cost $560,000.

Tex., Houston—N. D. Naman, 612 Second National Bank Bldg., awarded contract for the construction of a 10-story hotel at Texas Ave. and La Branch St. to Tellepsen Construction Co., 2112 Main St., $500,000.

Tex., Houston—R. S. Sterling, c/o Sanguinett, Staats & Hedrick, First National Bank Bldg., Fort Worth, Archts., plans the construction of a 22 story office building, at Texas and Fannin Sts. Estimated cost $2,000,000. M. J. Sullivan, Carter Bldg., Ft. Worth, is engineer.

Tex., Killene—City, H. N. Law, Mayor, voted $16,000 bonds for water works improvements, including pumping equipment laying additional mains, etc. Engineer not selected.

Tex., Mexia—Phillips Ice & Coal Co. will soon receive bids for the construction of a 1-story, 35-ton capacity, ice plant here. Estimated cost, $50,000. Equipment will be required.

Tex., Ralls—Texas Utilities Co., Ballinger, will soon receive bids for the construction of a 15-ton capacity ice plant here. Estimated cost $35,000. Machinery will be required.

Tex., Rule—Rule Ice Co., O. H. Hammer, Pres., will soon receive bids for the construction of an ice plant, with complete equipment. Estimated cost $28,000. Private plans.

Tex., Rusk—City, is having plans prepared for the construction of a dam, spillway, filteration plant, pumping plant, etc. Estimated cost $55,000. F. A. Jones, Lufkin is engineer.

Wis., Cedarburg—Common Council, J. Armbruster, mayor, plans the construction of a power and light plant, with equipment including Diesel generating unit of 400 to 500 hp. capacity. Estimated cost $40,000. E. Schneider, is superintendent of water and light departments.

Wis., Milwaukee — American Wholesale Grocery Co., 235 Broadway, is having plans prepared for the construction of a 4-story warehouse and cold storage plant, on Chicago St. Estimated cost $60,000. Owner will purchase refrigerating machinery. W. J. Kozick, 664 26th St., is architect.

Wis., Milwaukee—English Woolen Mills, 222 Third St., awarded contract for the construction of an 8-story, office and store building, at Third and Wells St., to T. Stark & Co., 130 Muskego Ave. Estimated cost, $750,000.

Ont., Ottawa — Ontario Hydro Electric Comn., A. Beck, Chrn., Toronto, will soon receive bids for the building and dam for the hydro electric development, at Rocke Fondu, on the Ottawa River, about 35 miles above Ottawa. Estimated cost $5,000,000. Development has been authorized by Ontario Provincial Government.

Que., Montreal—F. L. Hammond-Richards, 1054 Bleury St., is in the market for 5 kw., 110 v., 1,650 or 1,800 r.p.m., d.c. generator.

Que., Three Rivers—United Manufacturing Co., Montreal, has had plans prepared for the construction of a water power development. Estimated cost $6,000,000. Waller J. Francis & Co., Montreal, is engineer.